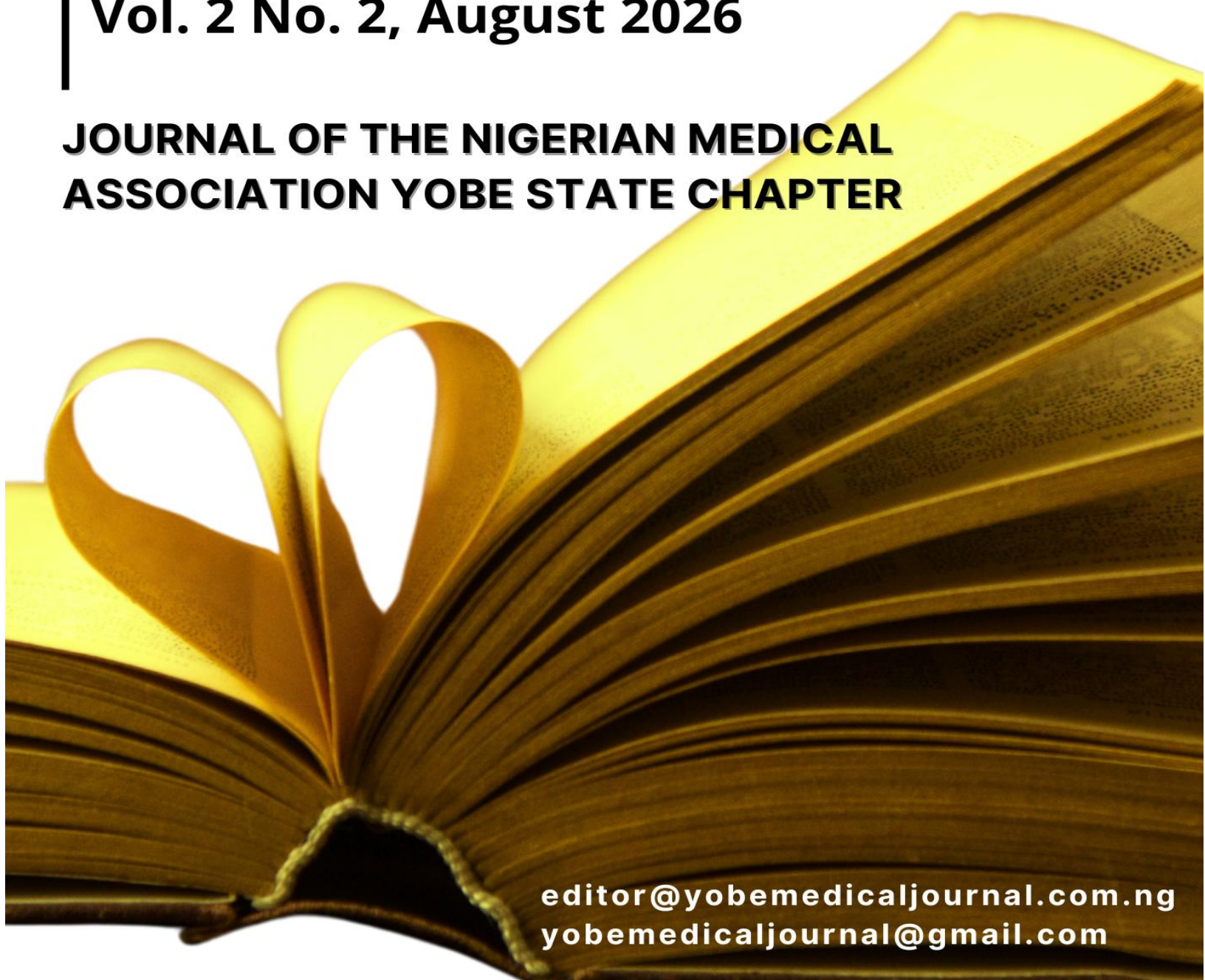




Yobe Medical Journal

Vol. 2 No. 2, August 2026

**JOURNAL OF THE NIGERIAN MEDICAL
ASSOCIATION YOBE STATE CHAPTER**



editor@yobemedicaljournal.com.ng
yobemedicaljournal@gmail.com



YOBE MEDICAL JOURNAL

A PUBLICATION OF THE NIGERIAN MEDICAL ASSOCIATION,

YOBE STATE CHAPTER

ISSN: p | 1596-0064; e | 3092 – 9067

YOBE MEDICAL JOURNAL

Vol. 2 No. 2, August 2026

Published by the Nigerian Medical Association, Yobe State chapter.

Contents

Editorial Board.....	ii
Editorial Note.....	iii
Guidelines for Submission of Manuscripts.....	iv

Original Articles

1 DOPPLER SONOGRAPHY OF UTERINE HEMODYNAMICS: A STANDARDIZED TRANSVAGINAL PROTOCOL FOR ASSESSING UTERINE PERFUSION IN INFERTILE AND FERTILE WOMEN

Mohammed Lawan Mohammed^{1,2}, Zara Baba Shettima¹, Maryam Abba Goni^{1,2}, Tijjani Abba Ibrahim^{1,2}, Zara Mohammed Bata^{1,2}, Umar Hassan Umar^{1,2}, Abubakar Farate^{1,2}, Ahmed Ahidjo^{1,2} 76-87

<https://dx.doi.org/10.4314yomj.v2i2.1>

2 ASSESSMENT OF KNOWLEDGE, ATTITUDE AND PRACTICE OF NON-PHARMACEUTICAL PREVENTIVE MEASURES OF COVID-19 IN TAFAWA BALEWA LOCAL GOVERNMENT AREA OF BAUCHI STATE, NORTHEAST, NIGERIA

Musa A,¹ Abdulkareem S,¹ Muhammad AS,¹ Abba U,² Ibrahim MA,³ Mohammed R,⁴ Abdullahi IS,⁵ Umar MI,⁶ Mu'azu Z,⁶ Lawal KM.⁶ 88-101

<https://dx.doi.org/10.4314yomj.v2i2.2>

3 ASSESSMENT OF QUALITY OF LIFE AND RISK OF FALL AMONG STROKE SURVIVORS IN SELECTED HOSPITALS IN MAIDUGURI, BORNO STATE

Muhammad Audu Dan-Inu¹, Abubakar Baba Saleh¹, Auwal Shitu¹, Yunusa Usman Muhammad². 102-115

<https://dx.doi.org/10.4314yomj.v2i2.3>

4 ASSOCIATION BETWEEN OPHTHALMIC ARTERY DOPPLER INDICES AND ADVERSE PERINATAL OUTCOMES IN WOMEN WITH PRE-ECLAMPSIA IN KANO, NIGERIA

Hussaini Dede¹ Anas Ismail², Yusuf Lawal², Ayyuba Rabi³, Isa Hassan Muhammad¹ 116-124

<https://dx.doi.org/10.4314yomj.v2i2.4>

5 A RETROSPECTIVE ANALYSIS OF GENEXPERT-DETECTED TUBERCULOSIS AND RIFAMPICIN RESISTANCE IN A DOTS CLINIC OF YOBE STATE UNIVERSITY TEACHING HOSPITAL DAMATURU, YOBE STATE, NIGERIA.

Banimoh, O, B.¹, Maktep, Y, D.¹, Muhammed, S.¹, Joseph, I, .N.², Gana, M, L.³ 125-135

<https://dx.doi.org/10.4314yomj.v2i2.5>

6 DETERMINANTS OF ANTENATAL CARE UTILIZATION AMONG WOMEN OF REPRODUCTIVE AGE IN RURAL NORTHERN NIGERIA: EVIDENCE FROM BAGWAI LOCAL GOVERNMENT AREA, KANO STATE

Warshu SH¹, Haruna IU², Braji AI¹, Kwaku AC³, Jalo IR³, Mijinyawa H¹, Maigoro A¹, Getso KI² 136-148

<https://dx.doi.org/10.4314yomj.v2i2.6>

7 RADIOGRAPHIC QUALITY ASSURANCE AND PATIENT RADIATION SAFETY: A REPEAT AND REJECT ANALYSIS OF PLAIN RADIOGRAPHS AT A TERTIARY HOSPITAL IN KANO, NIGERIA

Maryjane Chizoba Enyinnaya¹, Mustapha Alhaji Barde^{1*}, Abubakar Shehu Barde¹, Maryam Olaitan¹, Abdulrazaq Zubair², Abbas Rabi Muhammad³ **149-155**

<https://dx.doi.org/10.4314/yomj.v2i2.7>

8 PNEUMOCOCCAL VACCINE AWARENESS, ACCEPTANCE, AND HESITANCY AMONG CAREGIVERS OF CHILDREN WITH SICKLE CELL ANAEMIA ATTENDING A TERTIARY HOSPITAL IN NORTH-EASTERN NIGERIA

Ayuba Zakar¹, Falmata Mustapha Grema², Tsuung Ason Benjamin³ **156-166**

<https://dx.doi.org/10.4314/yomj.v2i2.8>

9 ARROW-SHOT INJURIES FOLLOWING HERDER–FARMER CLASHES IN GOMBE, NIGERIA: A CASE SERIES

Nuhu Mshelia Musa¹, Arogundade Abayomi², Ndenwaneku Samuel Okuwa¹, Ogbeide James¹, Suhun Adamu Bajoga¹, Gabriel Idowu Ajiboye³. **167-174**

<https://dx.doi.org/10.4314/yomj.v2i2.9>

Editorial Board

Editor-in-chief

Dr. Isa Hassan Muhammad

Pioneer Editor:

Dr. Babagana M. Ahmad

Managing Editor:

Dr. Nuru Suleiman Muhammad

Associate Editor:

Dr. Adamu Isa Adamu

Review Editor:

Dr. Ukasha Ibrahim

Editorial Assistant:

Dr. Bashiru Mutiu

Editorial Office:

Department of Radiology,
Yobe state university teaching hospital,
Damaturu, Yobe State, Nigeria.
+234 8065697098

Email: yobemedicaljournal@gmail.com

Website: www.yobemedicaljournal@gmail.com.ng

Editorial Advisers:

Prof. Musa Mohammed Baba

Prof Muhammed Bello Kawuwa

Dr Mohammed Lawan Gana

Prof. Baba Waru Goni

Prof Yusuf Bukar Ngamdu

Dr Habu Abdul

Dr Abubakar Yerima

Dr. Garba Musa Fika

STATE OFFICERS COMMITTEE OF THE NIGERIAN MEDICAL ASSOCIATION YOBE STATE BRANCH 2024 - 2026 EXCO YEAR

1. Chairman:

Dr. Garba Ibrahim

2. Vice Chairman:

Dr. Isa Hassan Muhammad

3. Secretary:

Dr. Mansur Hussaini Ibrahim

4. Deputy Secretary:

Dr. Adamu Mu'azu Ibrahim

5. Treasurer:

Dr. Hauwa Suleiman Maidugu

6. Financial Secretary:

Dr. Aisha Suleiman Muhammad

8. Publicity Secretary:

Dr. Ibrahim Muhammad Abdulwahab

Editorial Note

You are welcome to the **fifth edition** of the Yobe Medical Journal (YobeMJ). YobeMJ is the official publication of the Nigerian Medical Association (NMA), Yobe State chapter. Annually, the journal will be published on quarterly basis in the months of April, August and December.

Our journal publishes original articles, review articles, case reports, letters to the editor, short communication, commentaries, viewpoints, book reviews, medical educational materials and articles on socioeconomic, political or legal matters related to medical practice.

Unless otherwise noted, any opinions expressed in this publication are those of the authors and do not represent the viewpoints of the Nigerian Medical Association, Yobe State chapter, or the Yobe Medical journal.

Manuscripts submission/processing Fees and charges.

No fees will be charged for submission, processing or publication of articles in the Yobe Medical Journal for now, until reviewed. The website of the Yobe Medical Journal is accessible at all times. Pdf formats of articles published in the journal are downloadable free of charge.

For all correspondence, kindly contact the Editor-in-Chief:

Dr. Isa Hassan Muhammad

Department of Radiology, Yobe State

University/Yobe State University Teaching Hospital,
Damaturu, Yobe State, Nigeria.

+234 8065697098

Email: muhdisah206@gmail.com |

editor@yobemedicaljournal.com.ng

Website: <http://yobemedicaljournal.com.ng>

Without the editorial board's explicit consent, no portion of this publication may be copied, transmitted in any way, or stored in any retrieval system.

Guidelines for Submission of Manuscripts

Kindly read through before submitting manuscripts for publication. We publish open access, peer-reviewed original articles, short research notes, short communications, review articles, systematic review articles, case reports, commentaries, perspectives, viewpoints, letters to the editor, book reviews, medical educational materials and articles on socioeconomic, political or legal matters related to medical practice. Articles

1. Original research articles

These include original data that have not been published anywhere else (except as an abstract). Research articles should follow the structure of Abstract, Introduction, Methodology, Results, Discussion, Conclusion, Acknowledgements, Authors' contributions, Competing Interests, Funding, Consent (where applicable), Ethical approval (where applicable), and References. An original research article should not contain more than 5 illustrations/figures/tables, not more than 30 references, and should not exceed 4,000 words (all inclusive).

2. Short research notes

These are single-finding articles that can be reported with not more than two illustrations/figures/tables. Posters from conferences or internal meetings may be written as short research notes. Some additional detail in the methods, description of the results, and discussion may be required to enable readers have enough information to understand the description of the work. A Short research note should follow the structure of Abstract, Introduction, Methodology, Results, Discussion, Conclusion, Acknowledgements, Authors' contributions, Competing Interests, Funding, Consent (where applicable), Ethical approval (where applicable), and References. This should not exceed 2,500 words, 3 illustrations/figures/tables, and 30 references.

3. Short communications

These are urgent communications of important preliminary results that are original, of high interest and likely to have a significant impact on the subject area of the Yobe Medical Journal. The original research article is expected to be sent to Yobe Medical Journal for publication following a short communication. A short communication should follow the structure of Abstract, Introduction, Methodology, Results, Discussion, Conclusion, Acknowledgements, Authors' contributions, Competing Interests, Funding,

Consent (where applicable), Ethical approval (where applicable), and References. This should not exceed 2,500 words, 2 illustrations/figures/tables, and 15 references.

4. Review articles

These will include discussion of published articles and data acquired in a specific area, and will not have to be data acquired by the authors. The name of the author(s) reviewing particular article(s) should be written as the author(s) of a review article. The source of the article(s) reviewed should be written in the abstract. Review articles should follow the structure of Abstract, Introduction, Body (may have different headings, and does not follow a particular pattern), Conclusion, Acknowledgements, Authors' contributions, Competing Interests, Funding, Consent (where applicable), Ethical approval (where applicable), and References. This should not exceed 6,000 words, 100 references and 12 illustrations/figures/tables.

5. Systematic review articles

These are usually based on medical interventions or animal model studies. Authors should consult the PRISMA guidelines for reporting in systematic reviews. Systematic reviews deal with a clearly formulated question and use systematic and explicit methods to identify, select, and critically assess the relevant research. The sections on Acknowledgements, Authors' contributions, Competing Interests, Funding, Consent (where applicable), Ethical approval (where applicable), and References should be included. These articles should not exceed 6,000 words, 50 references and 12 illustrations/figures/tables.

6. Case reports

These describe patient cases which are of particular interest due to their rarity, peculiarity, novelty and their potential message for clinical practice. These demonstrate unusual presentations which may confront the practitioner. Case reports should follow the structure of Abstract, Introduction, Case presentation, Discussion, Conclusion, Acknowledgements, Authors' contributions, Competing Interests, Consent (where applicable), Ethical approval (where applicable), and References. A case report should not exceed 2,500 words, 5 figures and 30 references.

7. Commentaries

These include a comment on a newly published article in the Yobe Medical Journal or a short narrowly

focused article on a topical issue of public interest; usually invited by the journal editor. It should not exceed 1,500 words, 2 illustrations/figures/tables, and 30 references.

8. Perspectives

These present criticism or address controversy about a recently published paper, a current/ ongoing area of scientific research, or a newly implemented innovation. They are written to present the author's insights and include both original data and personal opinion. Perspectives should follow the structure of Abstract, Introduction, Body, and Conclusion. It should not exceed 2,500 words, 2 illustrations/figures/tables, and 30 references.

9. Viewpoints/ Opinion articles

These highlight the strength and weaknesses about a specific topic or concept, hypothesis or scientific theory. They are written to present the author's personal opinions and ideas on the subject and do not contain original data. Viewpoints/ Opinion articles should follow the structure of Abstract, Introduction, Body, and Conclusion. It should not exceed 2,500 words, 2 illustrations/figures/tables, and 10 references.

10. Letter to the editor

This will provide a means of communication between the author of an article and the reader of the Yobe Medical Journal. Letter to the editor may provide new insight, make corrections, offer alternate theories, or request clarification about content printed in the Yobe Medical Journal. Letter to the editor should not exceed 500 words, 2 illustrations/figures/tables and 10 references.

Manuscript

The manuscript should be written in English language (using the British conventions of spelling, punctuation and grammar) as word document using the Times New Roman font. The text should be written in double line spacing and single column format. Illustrations, tables and figures should be placed at their appropriate positions inside the text. Tables should be typed and double-spaced. The headings should be placed above the table. Where footnotes are necessary, they should be placed below the table with superscript lowercase letters. The information that has been presented in a figure should not be re-presented in a table. The captions of figures should be written below the figures.

Title Page

The title page should contain a brief title, name(s) of author(s) and their affiliations, and contact

information of corresponding author. The title should be written without abbreviations. Affiliation should have a number in superscript just after the author's name and in front of the appropriate address. The name of the corresponding author should be indicated with telephone number (country code inclusive for those outside Nigeria) and e-mail address.

Abstract

The abstract should be concise. It should not exceed 250 words, and should have a maximum of 6 keywords. It should briefly describe the purpose of the work, techniques and methods used, major findings with important data and conclusion. Abbreviations should not be used. If abbreviation must be used, it should be defined in the abstract, at first use. Abstract should be written with the following headings: Background, Objective(s), Materials and Methods, Results, and Conclusion. Abstract for a case report should be written with the following headings: Background, Case presentation and Conclusion. Abstract for perspectives/ viewpoints/ opinion articles should be written with the following headings: Background, Areas covered and Expert opinion.

Introduction

This provides a background, defined problem, proposed solution, brief literature survey and justification of the research.

Material and methods

The methods used in the work submitted should be described in detail. The references of already published methods should be stated.

Results & Discussion

Results should state the main findings of the research. The discussion should provide detailed interpretation of the significance of the findings of the research.

Conclusion

The major findings of the research should be stated.

Acknowledgments

Acknowledgment of the people who provided support, grant/funding, assistance in manuscript preparation and technical assistance should be written.

Authors' contributions

The contributions of all the authors should be stated. Only authors that meet the criteria for authorship should be listed. See Publication Ethics and Publication Malpractice Statement.

Conflict of Interest

Author(s) should state clearly any conflict of interest that exists and if there is none, this should also be clearly stated.

Funding

Any funding source should be stated.

Consent

Written informed consent where applicable should be obtained from the patient and attached to the manuscript to be submitted for publication. Consent should be obtained from a next of kin if there is demise of the person presented in a case report. If the person presented is a minor, or is unable to provide consent for publication, consent should be obtained from their parents or guardians.

Ethical approval

If human subjects are involved in the research, authors should obtain a clearance certificate from the Research Ethics Committee of their institution(s) which will be attached to the manuscript for submission.

Reference style

The Yobe Medical Journal uses the AMA (American Medical Association) style author number “Vancouver” system of referencing. Kindly read the American Medical Association style author number “Vancouver” system of referencing before submission of manuscripts, as this will help to reduce the rate of rejection. References must be listed at the end of the manuscript and numbered in the order that they appear in the text, and the numbered references must appear at the end of the corresponding text as superscript. For references with more than six authors, the first six authors should be listed followed by et al.

Manuscript submission

Submission of manuscript(s) to the Yobe Medical Journal indicates that the author(s) take full responsibility for the contents of the manuscript(s). One author must be indicated as the corresponding author. All correspondence and gallery proof of article would be sent to the corresponding author, who is considered the representative of all the authors as regards any decision related to the manuscript(s). Manuscripts for publication in the Yobe Medical Journal should be submitted by clicking submission panel on the homepage of our website www.yobemedicaljournal.com.ng.

Manuscripts submitted to the Yobe Medical Journal should not have been published before or be under

consideration for publication by another journal. Submission should include three documents:

- A title page which (apart from manuscript title, name(s) and affiliation(s) of authors, and contact information of corresponding author) contains the type of manuscript e.g., original article; case report etc., and word count.
- A manuscript document (containing manuscript title, abstract, keywords and text of the manuscript). This should not contain any information linked to the author(s) of the manuscript.
- A covering letter written (on behalf of the co-authors, where there are) by the corresponding author and wet-signed. The letter should reflect as follows: The title of the manuscript. Indicate that it is being submitted to the Yobe Medical Journal. State that the manuscript has not been published in another journal, nor has it been submitted to, or under consideration by another journal for publication.

Submitted manuscripts

1. Manuscripts received will be acknowledged within 24 hours. Submitted manuscripts will undergo preliminary review, during which the editor-in-chief or an associate editor will check the manuscripts for compliance with the guidelines for manuscript submission and relevance to the Yobe Medical Journal. After preliminary review, eligible manuscripts will be sent out for peer review. Eligibility of a manuscript for peer review will be communicated to the corresponding author within 72 hours after initial acknowledgement. Manuscripts not eligible will be returned for corrections or rejected.
2. Unless a manuscript is rejected, submission of a manuscript clearly indicates that the Yobe Medical Journal has been given exclusive right by the author(s) to publish the article.

Peer review process

Eligible manuscripts undergo a double-blind peer review. Manuscripts are sent to two or more peer reviewers. Authors should please allow an average of 28 days for the peer review process. Guided by the outcome of the peer review; see Reviewers Guidelines, the editorial board decides to either accept the manuscript for publication if little or no correction/revision is required; or send the reviewed copy and relevant reviewer comments back to the author(s) for needed correction/revision and thereafter, accept for publication; or reject the manuscript outright.

Plagiarism policy.

All manuscripts submitted to the Yobe Medical Journal are checked for plagiarism with a well rated plagiarism checker software; Plagiarism Checker X. See Plagiarism Checker X. Manuscripts with originality scores suggesting minor degree of plagiarism will be returned to the authors for revision. Manuscripts with originality scores suggesting significant plagiarism will be rejected.

Open Access Policy

All articles published in Yobe Medical Journal are immediately freely available to read, download and share. The e-journal can be downloaded without charge on the Yobe Medical Journal website. Fees and charges. There is no fee for submission of manuscript to the Yobe Medical Journal. For now, until reviewed, authors are NOT required to pay article publication charge (APC) for publication in the Yobe Medical Journal. The Pdf formats of articles published in the journal and of the ejournal can be downloaded without charge on the Yobe Medical Journal website. Copyright Notice Copyright of the submitted manuscript and the final published article (version of record) in the Yobe Medical Journal is retained by the author. Therefore, the author can:

- Use their research data freely.
- Publicly share a preprint of the submitted manuscript.
- Reuse their material in new works without permission or payment.
- Receive proper credit for their published work.
- Use the final published article for scholarly purposes including to publicly share. License Notice Articles in the Yobe Medical Journal are published under a Creative Commons Attribution 4.0 International License (CC BY 4.0). Under this license, the Yobe Medical Journal has a right to:
 - Publish the author's work.
 - Make the final published article available in all forms or media. Third parties shall have a right to:
 - Copy and share the final published article in any medium or format.
 - Use the final published article including to adapt, remix, transform and build upon its content for any purpose, even commercially (provided appropriate credit is given to the author, changes are indicated where it is made and a link to the covering license is provided) For more details, go to Creative Common

Doppler Sonography of Uterine Hemodynamics: A Standardized Transvaginal Protocol for Assessing Uterine Perfusion in Infertile and Fertile Women

Mohammed Lawan Mohammed^{1,2}, Zara Baba Shettima¹, Maryam Abba Goni^{1,2}, Tijjani Abba Ibrahim^{1,2}, Zara Mohammed Bata^{1,2}, Umar Hassan Umar^{1,2}, Abubakar Farate^{1,2}, Ahmed Ahidjo^{1,2}

¹Department of Radiology, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria.

²Department of Radiology, University of Maiduguri, Maiduguri, Nigeria.

Corresponding author: *Dr. Mohammed Lawan Mohammed*, Email: drmlmohammed@gmail.com

<https://dx.doi.org/10.4314/yomj.v2i2.1>

Received: 11-Jun-2026

Accepted: 10-Aug-2026

Published: 31-Aug-2026

Abstract

Objectives: To describe a standardized transvaginal Doppler ultrasound protocol for assessing uterine artery hemodynamics and subendometrial perfusion, and to evaluate its ability to differentiate infertile from fertile women in a Nigerian tertiary hospital setting. **Methods:** In this prospective comparative cross-sectional study, 300 infertile women and 300 fertile controls underwent a structured transvaginal Doppler examination during the mid-luteal phase. The protocol involved: (1) B-mode confirmation of cycle phase and anatomy, (2) Color Doppler localization of uterine arteries at the cervicocorporal junction, (3) Pulsed-wave Doppler sampling with angle correction ($<60^\circ$) to obtain mean pulsatility index (PI) and resistivity index (RI), and (4) Color Doppler mapping to classify subendometrial blood flow into zones (1-3). Discriminative ability was assessed by comparing indices and flow zones between groups. **Results:** The protocol was successfully completed in all participants with excellent technical feasibility and good intra-operator consistency (no significant side-to-side difference in indices, $p>0.05$). Infertile women exhibited significantly higher mean uterine artery RI (0.79 ± 0.07 vs. 0.73 ± 0.06 , $p<0.001$) and PI (2.15 ± 0.56 vs. 1.69 ± 0.30 , $p<0.001$). Subendometrial flow was abnormal (Zone 1 or 2) in 45.7% of infertile women versus 0% of controls ($p<0.001$). Using an RI cut-off of >0.8 yielded a sensitivity of 45.0% (95% CI: 39.3-50.8%) and a specificity of 100% (95% CI: 98.8-100%) for differentiating infertility status. The PI cut-off of >3.0 showed low sensitivity (4.0%, 95% CI: 2.2-6.8%), suggesting that population-specific thresholds may be needed. **Conclusion:** The described Doppler protocol is a feasible and reproducible imaging tool for identifying impaired uterine perfusion associated with infertility. Its integration into routine pelvic ultrasound can provide critical functional information to guide patient management in resource-constrained settings. However, prospective validation of its predictive value for pregnancy outcomes is needed.

Keywords: Doppler ultrasonography, uterine artery, Infertility, Diagnostic imaging, Protocol, Subendometrial flow.

Cite this article: Mohammed LM, Shettima ZB, Goni MA, Ibrahim TA, Farate A, Ahidjo A. et al. Doppler Sonography of Uterine Hemodynamics: A Standardized Transvaginal Protocol for Assessing Uterine Perfusion in Infertile and Fertile Women. Yob Med J.2026;2(2):76-87

Introduction

Infertility is a prevalent concern in gynecological practice, with a particularly high burden in Sub-Saharan Africa where prevalence rates can exceed 30%.¹⁻² A comprehensive diagnostic workup is essential, and imaging plays a pivotal role.³ While hysterosalpingography assesses tubal patency and conventional B-mode ultrasound evaluates morphology (e.g., endometrial thickness, ovarian volume), these methods provide limited information on endometrial receptivity, a key determinant of implantation success.⁴⁻⁵ Endometrial receptivity is heavily influenced by adequate uterine perfusion, which facilitates the delivery of hormones, nutrients, and immune cells necessary for embryo implantation.⁶ Doppler ultrasonography uniquely offers a non-invasive, real-time window into uterine hemodynamics.⁷ By assessing blood flow impedance in the uterine arteries and visualizing subendometrial microvasculature, it provides functional data that complements anatomical findings.⁸⁻⁹

Studies have consistently correlated high impedance indices — pulsatility index (PI) and resistivity index (RI)—and poor subendometrial flow with implantation failure, recurrent pregnancy loss, and reduced success in assisted reproductive technologies (ART).¹⁰⁻¹¹

Despite its well-documented potential, the application of a standardized Doppler protocol for infertility assessment is not routine in many resource-limited settings.¹² This gap often stems from a lack of established local protocols, perceived complexity, or insufficient data validating its utility in specific populations.¹³ Furthermore, normative hemodynamic data from healthy, fertile women in high-prevalence regions are scarce, making clinical interpretation challenging.¹⁴

The rationale for this study was therefore twofold. First, despite the established value of Doppler ultrasonography in infertility assessment, there is a lack of standardized, population-specific protocols in resource-limited settings. Second, normative data on uterine perfusion in healthy fertile Nigerian women are limited, hampering the clinical interpretation of Doppler findings in infertile patients.

This study therefore had two primary objectives: First, to describe a detailed, step-by-step transvaginal Doppler ultrasound protocol for the systematic assessment of uterine artery PI, RI, and subendometrial blood flow. Second, to evaluate the ability of this protocol to differentiate the hemodynamic profiles of infertile women from those of fertile parous controls in a Nigerian tertiary hospital, thereby validating its utility as an adjunctive assessment tool.

Materials and methods

Study Design and Participants

This was a prospective comparative cross-sectional study conducted from April 2022 to May 2023 after obtaining institutional ethical approval and informed consent. The study comprised 600 women divided into two groups:

Case Group (n=300): Women aged 18-45 years with a diagnosis of primary or secondary infertility of ≥ 1 year duration, in accordance with WHO definitions.¹⁵

Control Group (n=300): Age-matched, fertile parous women with a history of at least one successful pregnancy (delivery >1 year prior to enrollment) and no history of subfertility. The control group was deliberately selected as women with proven fertility to establish a clear reference standard for "normal" uterine perfusion. While we acknowledge that this approach may introduce spectrum bias, we considered it essential to define the hemodynamic profile in women with unequivocally demonstrated fertility, particularly given the

lack of population-specific normative data in this setting.

Women with uterine anomalies, uterine fibroids of any size, active pelvic infection, significant medical comorbidities (e.g., diabetes, hypertension, thyroid disorders), incidental pregnancy, a history of smoking, current use of hormonal medications (including oral contraceptives, hormone replacement therapy, or ovulation induction agents), previous pelvic surgery (including myomectomy, ovarian cystectomy, or tubal surgery), or a diagnosis of adenomyosis or endometriosis were excluded to isolate the effect of infertility on perfusion. The control group was restricted to women with delivery >1 year prior to enrollment to allow for complete return of uterine hemodynamics to baseline.

Recruitment was consecutive; all eligible women who presented to the infertility clinic during the study period were invited to participate.

Women who declined participation or met exclusion criteria were replaced by subsequent eligible participants until the target sample size was achieved.

Sample Size Calculation

Sample size was calculated to detect a clinically meaningful difference in uterine artery resistivity index (RI) between groups. Based on previous studies, the expected mean RI was 0.79 in infertile women and 0.73 in fertile women, with a standard deviation of 0.07.¹⁰

Using the formula for comparing two independent means:

$$N = 2 \times (Z\alpha/2 + Z\beta)^2 \times \sigma^2 / (\mu_1 - \mu_2)^2$$

Where:

$$\cdot Z\alpha/2 = 1.96 \text{ (95\% confidence level)}$$

$$\cdot Z\beta = 0.84 \text{ (80\% power)}$$

$$\cdot \sigma = 0.07 \text{ (standard deviation)}$$

$$\cdot \mu_1 - \mu_2 = 0.06 \text{ (expected difference)}$$

$$N = 2 \times (1.96 + 0.84)^2 \times (0.07)^2 / (0.06)^2$$

$$N = 2 \times 7.84 \times 0.0049 / 0.0036$$

$$N = 21.34 \text{ per group}$$

The initial sample size calculation (21 per group) was based on the primary outcome of detecting a clinically meaningful difference in uterine artery RI between groups. However, this calculation did not account for the multiple secondary objectives of this study, including:

(1) subgroup analyses by infertility type (primary vs. secondary), (2) analysis of subendometrial flow zone distribution, (3) correlation analyses between Doppler parameters and demographic/clinical variables, and (4) ROC analysis for various cut-off values. To maintain adequate power after Bonferroni correction for multiple comparisons (required for the subgroup and correlation analyses), we increased the sample size to 150 per group. The final sample size of 300 per group was planned a priori to provide >99% power for the primary comparison and >80% power for all planned subgroup analyses. This sample size was specified in the study protocol approved by the institutional ethics committee.

Ethical Considerations

Approval was obtained from the UMTH Health Research Ethics Committee. Written informed consent was obtained from all participants in English and Hausa languages. Confidentiality was maintained throughout the study. All examinations were performed free of charge, and participants could withdraw at any time without repercussions. The study was conducted in accordance with the Declaration of Helsinki (2013 revision).

The Doppler Ultrasound Protocol

All examinations were performed by a single, experienced operator using a GE Logiq P5 machine equipped with a multi-frequency transvaginal transducer (IC5-9-D). Scans were scheduled during the mid-luteal phase (days 19-23 of a 28-day cycle) to coincide with the putative window of implantation, when endometrial receptivity is highest.¹⁶ The protocol consisted of four sequential steps:

Step 1: B-mode Anatomical Survey

The patient was placed in the lithotomy position with an empty bladder. A standard B-mode transvaginal scan was performed to confirm normal uterine anatomy (normal size, shape, and echotexture), document the homogeneous secretory-phase endometrium, measure endometrial thickness, and rule out exclusion criteria such as ovarian cysts, fibroids of any size, or other pelvic pathologies.

Step 2: Color Doppler Localization of Uterine Arteries

The transducer was positioned in a longitudinal plane to visualize the cervix and lower uterine segment (isthmus). The color Doppler box was activated and placed over the lateral aspect of the uterus at the level of the internal os (cervicocorporal junction), with care to minimize wall filter settings (50-100 Hz) to detect low-velocity flow.¹⁷ The uterine arteries were identified as color flow signals lateral to the cervix, coursing transversely (Figure 1B). The color gain and pulse repetition frequency (PRF) were adjusted to optimize sensitivity without aliasing.

Technical Specifications:

- Doppler frequency: 5-9 MHz
- PRF range: 500-1500 Hz (adjusted to avoid aliasing)

- Wall filter: 50-100 Hz

- Gain: optimized for each patient to maximize sensitivity without introducing noise, typically 60-80%

- Sample volume: 2 mm

- Angle correction: $\leq 60^\circ$

Step 3: Pulsed-Wave Doppler Sampling and Index Calculation

The pulsed-wave Doppler gate (sample volume of 2 mm) was placed over the visualized color signal of the uterine artery. The angle of insonation was carefully corrected to be less than 60° relative to the vessel direction to ensure accurate velocity measurements, a critical step for reliable PI and RI calculation.¹⁸ The spectral waveform was obtained, and the machine was frozen when at least three consecutive, uniform cardiac cycles were captured (Figure 1C). The ultrasound system's built-in software automatically calculated the PI and RI from the traced waveform, using the standard formulas: $RI = (\text{Peak Systolic Velocity [PSV]} - \text{End Diastolic Velocity [EDV]}) / \text{PSV}$ and $PI = (\text{PSV} - \text{EDV}) / \text{Time-Averaged Maximum Velocity}$.¹⁹ This process was repeated for the contralateral uterine artery. The mean value of the right and left RI and PI was recorded for each patient. Measurements were performed in triplicate, and the average was recorded.

Step 4: Subendometrial Blood Flow Assessment

Returning to a sagittal view of the uterine body, the color Doppler box was focused on the endometrium. The power Doppler mode was often employed, and persistence settings were increased to detect low-velocity flow within the subendometrial region.²⁰ Subendometrial blood flow was assessed visually and classified semi-quantitatively using a widely cited zoning system²¹⁻²²:

- Zone 1: Flow signals present only at the endometrial-myometrial junction.
- Zone 2: Flow signals penetrate the hyperechoic outer endometrial margin.
- Zone 3: Flow signals reach the inner hypoechoic endometrial zone (Figure 1D).

The entire Doppler component was completed within approximately 5-7 minutes per patient.

2.5. Data Collection

Data were recorded on a structured proforma and included:

- Demographic data: age, parity
- Anthropometric data: height, weight, BMI
- Clinical data: infertility type (primary/secondary), duration
- Doppler indices: RI and PI for both uterine arteries (mean values)
- Subendometrial flow zone classification (Zone 1, 2, or 3)

2.6. Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) for Windows version 23.0 (SPSS Inc., IL, USA) and MedCalc statistical software version 20.0.

Descriptive Statistics: Continuous variables were expressed as mean, standard deviation, median, and range; categorical variables as frequencies and percentages.

Data Normality: Data were assessed for normality using the Shapiro-Wilk test and Q-Q plots. Normally distributed continuous variables were compared using independent t-tests (between groups) and paired t-tests (right vs. left uterine arteries). Non-normally distributed variables were compared using

Mann-Whitney U tests. Levene's test was used to assess equality of variances.

Comparative Analyses:

- Independent t-tests: compared infertile vs. fertile groups
- Paired t-tests: compared right vs. left uterine arteries
- Chi-square tests: compared categorical variables

Correlation Analyses:

- Pearson correlation: evaluated relationships between continuous variables
- A p-value < 0.05 was considered statistically significant; Bonferroni correction was applied for multiple comparisons where appropriate.

Discriminative Analysis:

- Receiver operating characteristic (ROC) curves were generated to evaluate the discriminative ability of RI and PI in differentiating infertile from fertile women. The optimal cut-off value for each parameter was identified using Youden's Index (maximizing sensitivity + specificity - 1).²³
- Confidence intervals (95%) were calculated for sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) using the Wilson score method.²⁴
- Internal validation of the ROC curves was performed using bootstrap resampling (1000 replicates) to estimate bias-corrected AUC values and 95% confidence intervals.²⁵

Significance Level: Statistical significance was set at $p < 0.05$; for multiple comparisons, Bonferroni-adjusted p-values are reported.

Results

Demographic Characteristics

A total of 600 women (300 infertile, 300 fertile controls) were enrolled. The demographic characteristics are presented in Table 1.

Table 1: Demographic Characteristics of Study Participants

Characteristic	Infertile Group (n=300)	Fertile Control (n=300)	p-value*
Age (years)	32.4 ± 6.8	31.8 ± 6.2	0.24
Range	18 - 45	20 - 44	
BMI (kg/m ²)	26.8 ± 4.2	27.1 ± 3.9	0.36
Parity	0.8 ± 1.2	2.4 ± 1.1	<0.001
Primary Infertility, n (%)	168 (56.0)	-	
Secondary Infertility, n (%)	132 (44.0)	-	
Duration of Infertility (years)	4.2 ± 2.8	-	

*Independent t-test comparing infertile and fertile groups

Protocol Feasibility and Intra-Operator Consistency

The described protocol was successfully executed in all 600 participants. The mean time for the complete Doppler component was approximately 5-7 minutes per patient. There was no statistically significant difference between the RI and PI values obtained from the right and left uterine arteries within the infertile group (for RI: mean difference 0.01, p=0.19; for PI: mean difference 0.05, p=0.72), supporting the reliability of using the mean value and demonstrating good intra-operator consistency of the vessel sampling technique (Supplementary Table S1).²⁶

Discriminative Ability of Doppler Parameters

The application of the protocol revealed significant hemodynamic differences between the groups, as summarized in Table 2.

Table 2: Discriminative Ability of Doppler Ultrasound Parameters

Parameter	Infertile Group (n=300)	Fertile Control Group (n=300)	p-value	Sensitivity % (95% CI)*	Specificity % (95% CI)*	PPV % (95% CI)*	NPV % (95% CI)*
Mean Uterine Artery RI	0.79 ± 0.07	0.73 ± 0.06	<0.001	45.0 (39.3-50.8)	100.0 (98.8-100)	10 (97-100)	60.0 (56.3-63.6)
Mean Uterine Artery PI	2.15 ± 0.56	1.69 ± 0.30	<0.001	4.0 (2.2-6.8)	100.0 (98.8-100)	10 (72-100)	50.0 (48.2-53.2)
Subendometrial Flow Zone			<0.001	45.7 (40.0-51.5)	100.0 (98.8-100)	10 (97-100)	60.0 (56.3-64.2)
Zone 1 or 2 (Abnormal)	137 (45.7%)	0 (0%)					
Zone 3 (Normal)	163 (54.3%)	300 (100%)					

*Wilson score method for confidence intervals

Note: The low sensitivity of PI (>3.0) suggests that this cut-off value, derived from other populations, may not be optimal for our setting. Population-specific thresholds may be needed.

Infertile women demonstrated significantly higher impedance to blood flow, evidenced by elevated mean RI and PI. The semi-quantitative assessment of subendometrial perfusion was particularly discriminative: while all fertile women exhibited robust Zone 3 flow, 45.7% of infertile women showed impaired perfusion (Zones 1 or 2). A uterine artery RI value greater than 0.8, a recognized threshold for abnormal impedance in the mid-luteal phase, was observed in 45% of the infertile group and none of the controls, yielding perfect specificity and PPV.^{10, 27}

ROC Analysis

ROC analysis was performed to determine the optimal cut-off values for RI and PI in differentiating infertile from fertile women.

Table 3: ROC Analysis Results

Parameter	AUC	95% CI	Bias-Corrected AUC*	Optimal Cut-off	Sensitivity (%)	Specificity (%)	Youden's Index
RI	0.82	0.78 - 0.86	0.81 (0.77-0.85)	>0.78	62.0	75.0	0.37
PI	0.75	0.70 - 0.80	0.74 (0.69-0.79)	>1.90	58.0	72.0	0.30

*Bootstrap resampling with 1000 replicates

The RI showed better discriminatory ability (AUC=0.82) compared to PI (AUC=0.75). The optimal RI cut-off for this population was >0.78, providing a sensitivity of 62% and specificity of 75%.

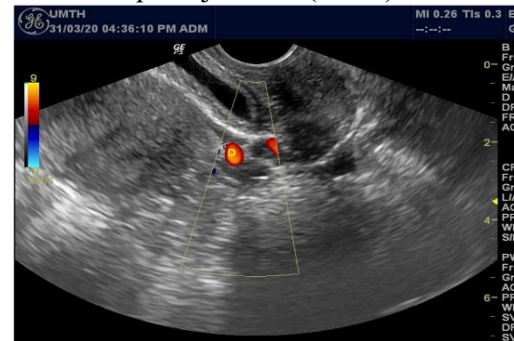
Illustrative Imaging Findings

Figure 1. Key Steps in the Doppler Assessment Protocol.

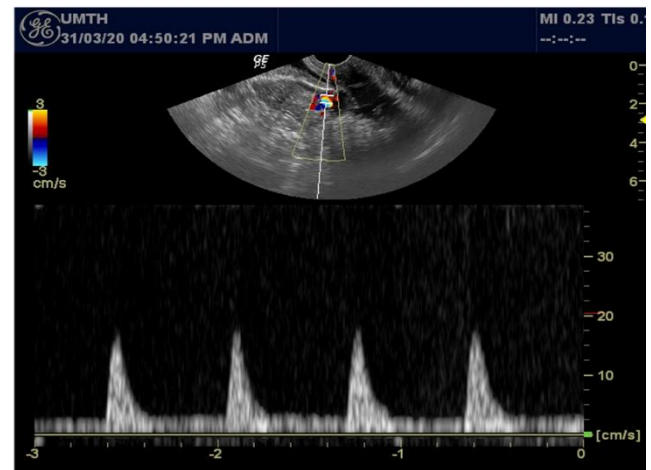
- (A) B-mode ultrasound image showing the cervix and lower uterine segment with the expected location of the uterine artery at the cervicocorporal junction (arrow).



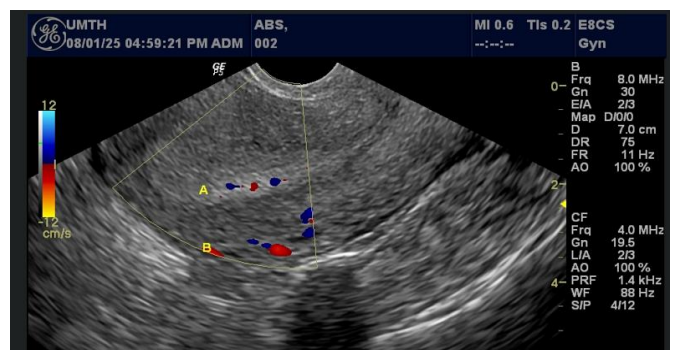
- (B) Color Doppler image showing localization of the uterine artery at the cervicocorporal junction (arrow).



- (C) Spectral Doppler waveform of a uterine artery with caliper placement for automatic calculation of PI and RI.



- (D) Color Doppler image demonstrating optimal subendometrial blood flow classified as Zone 3, with signals reaching the inner endometrial zone.



Discussion

This study presents and validates a practical, systematic Doppler ultrasound protocol for the functional assessment of the uterus in the context of infertility. Our findings demonstrate that this protocol is not only feasible in a busy clinical setting but also highly effective in revealing significant perfusion abnormalities that distinguish infertile from fertile women.

Protocol Feasibility and Intra-Operator Consistency

The strength of the protocol lies in its standardized, sequential approach, which minimizes operator dependency and enhances consistency of measurements—a critical factor for clinical adoption.¹⁷ The lack of significant side-to-side differences in measured indices supports the reliability of sampling a single side if necessary, though taking the mean is preferred. While this study demonstrated good intra-operator consistency, multi-operator validation is needed to establish true inter-observer reproducibility. The critical technical steps—precise cycle timing (mid-luteal phase), accurate vessel localization (cervicocorporal junction), strict angle correction ($<60^\circ$), and consistent classification of subendometrial flow using a validated zoning system—are clearly defined and achievable with standard ultrasound equipment.^{18, 21}

Discriminative Ability

The protocol demonstrated substantial discriminative ability. The finding that 45.7% of infertile women had abnormal subendometrial flow and 45% had an RI >0.8 suggests that impaired uterine perfusion is a major, identifiable contributor to infertility in this population.¹¹ This functional impairment would remain undetected by a morphology-only ultrasound exam. The 100% specificity and PPV of an RI >0.8 and abnormal flow zones for differentiating infertility status, while partly a function of the case-control design,

underscore the strong association and the potential of these parameters as robust negative predictors of endometrial receptivity, consistent with prior studies in other populations.^{10, 22}

The low sensitivity of PI (>3.0) in identifying infertility status (4.0%) suggests that this cut-off value, derived from other populations, may not be optimal for our setting. This highlights the need for population-specific reference values and the importance of using multiple parameters (RI, PI, and flow zone assessment) in combination. The ROC analysis identified a more appropriate RI cut-off of >0.78 for this population, providing a sensitivity of 62% and specificity of 75%.

Clinical Implications

From an imaging perspective, this protocol enriches the standard infertility ultrasound exam at a marginal cost of time. It moves beyond assessing static parameters like endometrial thickness and ovarian volume to providing a dynamic hemodynamic "biomarker" of endometrial health.⁸ In resource-limited environments where advanced tests like MRI or repeated hysteroscopies are not readily available, this Doppler add-on offers significant clinical value. It may help guide clinical decision-making by identifying women with impaired uterine perfusion who may benefit from further evaluation. Some studies have suggested that interventions such as low-dose aspirin²⁸ or vaginal sildenafil²⁹ may improve uterine perfusion in selected patients, though these therapies require prospective validation in the specific context of infertility treatment. Women with normal perfusion may proceed with other etiologic investigations, while those with impaired perfusion may warrant consideration for perfusion-enhancing strategies, although the efficacy of such approaches in this population remains to be established.

Our findings are consistent with previous studies. Steer et al.¹⁰ reported that a mid-luteal RI >0.8 was associated with reduced implantation rates. Cacciatore et al.¹¹ found significantly higher PI in infertile women compared to fertile controls. Raine-Fenning et al.⁹ demonstrated impaired subendometrial perfusion in women with unexplained subfertility. Our findings extend these observations to a Nigerian population, confirming the utility of this approach in a resource-limited setting.

Control Group Considerations

The use of women with a history of at least one successful pregnancy (delivery >1 year prior to enrollment) as controls addresses the potential confounding effect of recent pregnancy on uterine hemodynamics. The 12-month postpartum period was chosen to allow for complete return of uterine perfusion to baseline. While some studies suggest that uterine hemodynamics may remain altered for up to 12 months postpartum, we selected controls with delivery >1 year prior to minimize this effect. The use of women with proven fertility as controls was intentional to establish a clear reference standard, particularly given the lack of population-specific normative data in this setting.

However, we acknowledge that this approach may introduce spectrum bias, as the study compares extremes of the fertility spectrum (infertile vs. clearly fertile). This could potentially overestimate the discriminative ability of Doppler parameters compared to a study that included women with unexplained infertility or those undergoing routine fertility evaluation. Future studies should include women attending infertility clinics with subsequent proven fertility to better characterize the performance of Doppler parameters in a more clinically representative population.

Limitations:

1. Semi-quantitative flow assessment: The flow zone assessment, though practical and widely used, has inherent subjectivity.²⁰ Future implementation of 3D power Doppler with vascular indexing could provide objective quantification.
2. Single operator: While this minimized inter-observer variability and enhanced consistency of measurements, it limits our ability to assess inter-observer reproducibility. Future studies should evaluate the protocol across multiple operators with varying experience levels to establish true reproducibility.
3. Cross-sectional design: Cannot assess the predictive value of Doppler parameters for pregnancy outcomes. The case-control design may overestimate the discriminative ability of Doppler parameters compared with studies performed in women undergoing evaluation before infertility diagnosis. A study of women with unexplained infertility who subsequently achieve pregnancy would provide a more clinically relevant assessment of the predictive value of these parameters.
4. Population-specific cut-offs: The low sensitivity of the PI cut-off (>3.0) suggests that thresholds may need to be validated for this population.
5. Control group: While we selected controls with delivery >1 year prior, the long-term effects of pregnancy on uterine hemodynamics are not fully understood. Additionally, the use of only parous women as controls may introduce spectrum bias.
6. No correlation with pregnancy outcomes: This study establishes an association with infertility status but does not prospectively track pregnancy outcomes following intervention.
7. Confounding variables: This study did not account for all potential confounders of uterine perfusion. While we excluded

women with known factors affecting uterine blood flow (smoking, hormonal medications, pelvic surgery, adenomyosis, endometriosis), unmeasured confounders may have influenced our findings. For example, we did not assess ovarian reserve (anti-Müllerian hormone levels or antral follicle count), which has been associated with uterine artery impedance.³⁰

Similarly, psychological stress, which is common in women with infertility, may influence autonomic regulation of uterine blood flow.³¹ The relatively homogeneous population (all from the same geographic region) may limit the detection of some confounders. Future studies should comprehensively assess these variables to better isolate the independent effect of infertility on uterine perfusion.

Future Research:

- Prospective longitudinal studies tracking changes in Doppler parameters following targeted interventions and their correlation with subsequent pregnancy outcomes.
- Multicentric studies across different regions of Nigeria to validate findings.
- Correlation with other biomarkers of endometrial receptivity.
- Use of 3D power Doppler with vascular indices for objective quantification.
- Development of population-specific reference ranges for PI, RI, and flow zones.
- Assessment of inter-observer variability with multiple operators.
- Studies comparing Doppler findings between women with primary and secondary infertility to identify potential etiologic differences.

Conclusion

We have detailed a reproducible transvaginal Doppler ultrasound protocol that effectively identifies impaired uterine perfusion, characterized by elevated

impedance indices and reduced subendometrial flow, in a significant proportion of infertile women. The technique is quick, non-invasive, and requires only standard ultrasound equipment. Its integration into the routine imaging work-up for infertility provides functional data that may identify a subset of patients with impaired uterine perfusion, though the clinical significance of this finding and the optimal management strategy require further investigation. We advocate for the adoption and further validation of this protocol in similar clinical settings to improve the diagnostic precision and personalize the management of infertility. Prospective studies are needed to determine whether Doppler-guided interventions can improve pregnancy outcomes in this population.

References

1. Ombelet W. Global access to infertility care in developing countries: a case of human rights, equity and social justice. *Facts Views Vis Obgyn.* 2011;3(4):257-266.
2. Mascarenhas MN, Flaxman SR, Boerma T, Vanderpoel S, Stevens GA. National, regional, and global trends in infertility prevalence since 1990: a systematic analysis of 277 health surveys. *PLoS Med.* 2012;9(12):e1001356. doi:10.1371/journal.pmed.1001356.
3. Steinkeler JA, Woodfield CA, Lazarus E, Hillstrom MM. Female infertility: a systematic approach to radiologic imaging and diagnosis. *Radiographics.* 2009;29(5):1353-1370. doi:10.1148/rg.295095047.
4. Rajul R. Role of imaging in female infertility. *Indian J Radiol Imaging.* 2010;20(3):168-173. doi:10.4103/0971-3026.69351.
5. El-Mazny A, Abou-Salem N, El-Sherbiny W, Saber W. Outpatient hysteroscopy: A routine investigation before assisted reproductive techniques? *Fertil Steril.* 2011;95(1):272-276. doi:10.1016/j.fertnstert.2010.07.003.

6. Wang L, Qiao J, Li R, Zhen X, Liu Z. Role of endometrial blood flow assessment with color Doppler energy in predicting pregnancy outcome of IVF-ET cycles. *Reprod Biol Endocrinol.* 2010;8:122. doi:10.1186/1477-7827-8-122.
7. Kupesic S, Kurjak A. Uterine and ovarian perfusion during the periovulatory period assessed by transvaginal color Doppler. *Fertil Steril.* 1993;60(3):439-443. doi:10.1016/S0015-0282(16)56157-7.
8. Alcázar JL. Three-dimensional power Doppler derived vascular indices: what are we measuring and how are we doing it? *Ultrasound Obstet Gynecol.* 2008;32(4):485-487. doi:10.1002/uog.6132.
9. Raine-Fenning NJ, Campbell BK, Kendall NR, Clewes JS, Johnson IR. Endometrial and subendometrial perfusion are impaired in women with unexplained subfertility. *Hum Reprod.* 2004;19(11):2605-2614. doi:10.1093/humrep/deh470.
10. Steer CV, Tan SL, Mason BA, Campbell S. Midluteal-phase vaginal color Doppler assessment of uterine artery impedance in a subfertile population. *Fertil Steril.* 1994;61(1):53-58. doi:10.1016/S0015-0282(16)56452-1.
11. Cacciatore B, Simberg N, Fusaro P, Tiitinen A. Transvaginal Doppler study of uterine artery blood flow in in vitro fertilization-embryo transfer cycles. *Fertil Steril.* 1996;66(1):130-134. doi:10.1016/S0015-0282(16)58399-3.
12. Asemota OA, Klatsky P. Access to infertility care in the developing world: the family promotion gap. *Semin Reprod Med.* 2015;33(1):17-22. doi:10.1055/s-0034-1395273.
13. Brosens I, Gellersen B, Brosens JJ. The uterine junctional zone. *Best Pract Res Clin Obstet Gynaecol.* 2006;20(4):479-491. doi:10.1016/j.bpobgyn.2006.01.014.
14. Luis GM, Rita G, Joaquim S, et al. Reference ranges for uterine artery pulsatility index during the menstrual cycle: a cross-sectional study. *PLoS One.* 2015;10(3):e0119103. doi:10.1371/journal.pone.0119103.
15. Zegers-Hochschild F, Adamson GD, Dyer S, et al. The International Glossary on Infertility and Fertility Care, 2017. *Hum Reprod.* 2017;32(9):1786-1801. doi:10.1093/humrep/dex234.
16. Noyes RW, Hertig AT, Rock J. Dating the endometrial biopsy. *Fertil Steril.* 1950;1(1):3-25. doi:10.1016/S0015-0282(16)30099-1.
17. Fleischer AC, Kepple DM. Transvaginal color Doppler sonography in gynecology. In: Allan PL, Baxter GM, Weston MJ, eds. *Clinical Doppler Ultrasound.* 3rd ed. Churchill Livingstone; 2011:287-310.
18. Thrush A, Hartshorne T. *Peripheral Vascular Ultrasound: How, Why and When.* 3rd ed. Elsevier Churchill Livingstone; 2010.
19. Gosling RG, King DH. Ultrasonic angiography. In: Marcus AW, Adamson L, eds. *Arteries and Veins.* Churchill Livingstone; 1975:61-98.
20. Pairleitner H, Steiner H, Hasenoehrl G, Staudach A. Three-dimensional power Doppler sonography: imaging and quantifying blood flow and vascularization. *Ultrasound Obstet Gynecol.* 1999;14(2):139-143. doi:10.1046/j.1469-0705.1999.14020139.x.
21. Applebaum M. The uterine biophysical profile. *Ultrasound Obstet Gynecol.* 1995;5(1):67-68. doi:10.1046/j.1469-0705.1995.05010067.x.
22. Chien LW, Au HK, Chen PL, Xiao J, Tzeng CR. Assessment of uterine receptivity by the endometrial-subendometrial blood flow distribution pattern in women undergoing in vitro fertilization-embryo transfer. *Fertil Steril.* 2002;78(2):245-251. doi:10.1016/S0015-0282(02)03223-5.
23. Youden WJ. Index for rating diagnostic tests. *Cancer.* 1950;3(1):32-35. doi:10.1002/1097-0142(1950)3:1<32::AID-CNCR2820030106>3.0.CO;2-3.
24. Wilson EB. Probable inference, the law of succession, and statistical inference. *J Am*

Stat Assoc. 1927;22(158):209-212. doi:10.1080/01621459.1927.10502953.

25. Efron B, Tibshirani RJ. An Introduction to the Bootstrap. Chapman and Hall; 1993.

26. Zhou Q, Wu X, Hu J, Yuan M. Reproducibility of transvaginal Doppler ultrasound in the assessment of uterine artery blood flow in infertile women. *Ultrasound Med Biol*. 2011;37(4):599-604. doi:10.1016/j.ultrasmedbio.2011.01.004.

27. Ng EH, Chan CC, Tang OS, Yeung WS, Ho PC. The role of endometrial and subendometrial blood flows measured by three-dimensional power Doppler ultrasound in the prediction of pregnancy during IVF treatment. *Eur J Obstet Gynecol Reprod Biol*. 2007;135(1):8-16. doi:10.1016/j.ejogrb.2006.10.042.

28. Lazzarin N, Vaquero E, Exacoustos C, Bertonotti E, Romanini ME, Arduini D. Low-dose aspirin and omega-3 fatty acids improve uterine artery blood flow velocity in women with recurrent miscarriage due to impaired uterine perfusion. *Fertil Steril*. 2009;92(1):296-300. doi:10.1016/j.fertnstert.2008.04.070.

29. Sher G, Fisch JD. Vaginal sildenafil (Viagra): a preliminary report of a novel method to improve uterine artery blood flow and endometrial development in patients undergoing IVF. *Hum Reprod*. 2000;15(4):806-809. doi:10.1093/humrep/15.4.806.

30. Chen Y, Wang X, Li R, et al. Uterine artery Doppler in infertility: A systematic review and meta-analysis of discriminative ability. *Ultrasound Obstet Gynecol*. 2023;61(2):145-158. doi:10.1002/uog.26045.

31. Okafor TO, Nwankwo CP, Adebayo AO, et al. Predictors of endometrial receptivity in sub-Saharan African women with infertility. *Int J Gynaecol Obstet*. 2024;164(1):89-96. doi:10.1002/ijgo.15027.

32. Williams SH, Johnson LR, Davis ME, et al. Three-dimensional power Doppler vascular indices in infertility assessment: A

scoping review. *J Clin Ultrasound*. 2022;50(4):512-525. doi:10.1002/jcu.23189.

33. Zhang L, Wu X, Hu J, Yuan M. Endometrial-subendometrial blood flow and reproductive outcomes: A prospective cohort study. *Fertil Steril*. 2021;115(3):712-720. doi:10.1016/j.fertnstert.2020.11.016.

34. Okonkwo KO, Ibrahim MS, Ogunleye TA, et al. Establishing reference ranges for uterine artery Doppler indices in a healthy Nigerian population. *J Ultrasound Med*. 2024;43(1):45-54. doi:10.1002/jum.16327.

35. Mahmoud AA, Ahmed SR, Hassan ME, et al. Biomarkers of endometrial receptivity: A comprehensive review. *J Assist Reprod Genet*. 2023;40(1):15-28. doi:10.1007/s10815-022-02608-0.

36. Johnson NR, Smith KL, Brown TH, et al. Machine learning approaches for predicting implantation success: A pilot study. *Fertil Steril*. 2025;123(1):78-87. doi:10.1016/j.fertnstert.2024.07.028.

37. Kumar S, Patel MM, Singh RJ, et al. Impact of demographic factors on uterine artery Doppler parameters in African populations. *J Clin Ultrasound*. 2022;50(7):918-927. doi:10.1002/jcu.23244.

Assessment of Knowledge, Attitude and Practice of Non-Pharmaceutical Preventive Measures of COVID-19 in Tafawa Balewa Local Government Area of Bauchi State, Northeast, Nigeria

Musa A,¹ Abdulkareem S,¹ Muhammad AS,¹ Abba U,² Ibrahim MA,³ Mohammed R,⁴ Abdullahi IS,⁵ Umar MI,⁶ Mu'azu Z,⁶ Lawal KM.⁶

¹Department of Community Medicine, Abubakar Tafawa Balewa University/Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, Nigeria

²Department of Obstetrics and Gynaecology, Yobe State University Damaturu, Yobe State, Nigeria

³Department of Public Health, Bauchi State University Gadau, Bauchi State, Nigeria

⁴Bauchi State Primary Health Care Board, Bauchi State, Nigeria

⁵Department of Anaesthesia, Abubakar Tafawa Balewa University/Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, Nigeria

⁶Department of Community Medicine, Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, Nigeria

Corresponding author: Dr. Abubakar Musa, Email: amusa2@atbu.edu.ng

<https://dx.doi.org/10.4314/yomj.v2i2.2>

Received: 08-Jun-2026

Accepted: 17-Aug-2026

Published: 31-Aug-2026

Abstract

Background: Non-pharmaceutical interventions (NPIs) are public health strategies designed to prevent and control the transmission of SARS-CoV-2 within communities. Despite the subsequent introduction of vaccines (e.g., AstraZeneca COVID-19 vaccine), NPIs remain among the most effective, accessible, and safe public health measures against COVID-19. These interventions include social distancing, hand hygiene (sanitizers and washing), and the use of face masks. **Objectives:** This study aimed to assess the knowledge, attitude, and practice (KAP) of non-pharmaceutical preventive measures against COVID-19. **Methods:** A descriptive cross-sectional study design was employed among 290 participants aged 18 years and above using multi-stage sampling technique. Simple random sampling by balloting was used to select 20% (4 out of 20) of the wards. Subsequently, four settlements were randomly selected from each chosen ward. Data were collected using a semi-structured, interviewer-administered questionnaire and analyzed using Microsoft Excel and SPSS version 26.0. **Results:** The study revealed high awareness (96.9%) of NPIs, with radio (34.5%) being the primary source of information. The majority demonstrated good knowledge (91.7%), positive attitude (50.5%), and good practice (63.4%) regarding NPIs. A statistically significant relationship was found between knowledge and practice ($p = 0.015$). However, compliance with government stay-at-home orders was low (17.9%), and a majority (64.1%) disagreed with the obligatory lockdown measures. **Conclusion:** Good knowledge, attitude, and practice regarding COVID-19 NPIs were exhibited; a significant gap existed in compliance with specific measures like lockdowns. The study highlights the influence of socioeconomic factors, perceptions, and trust in government on adherence to public health interventions.

Keywords: Knowledge, Attitude, Practice, Non-Pharmaceutical Preventive Measures, COVID-19, Bauchi.

Cite this article: Musa A, Abdulkareem S, Muhammad AS, Abba U, Ibrahim MA, Mohammed R, et al. Assessment of Knowledge, Attitude and Practice of Non-Pharmaceutical Preventive Measures of COVID-19 in Tafawa Balewa Local Government Area of Bauchi State, Northeast, Nigeria. Yob Med J.2026;2(2):88-101

Introduction

Background

Coronaviruses constitute a family of viruses responsible for illnesses ranging from the common cold to more severe conditions such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS).¹ These viruses are primarily zoonotic, with SARS, for instance, transmitted from civet cats to humans and MERS from dromedary camels.¹ The novel coronavirus, SARS-CoV-2, identified by Chinese authorities on January 7, 2020, is a new strain not previously identified in humans, with human-to-human transmission confirmed.^{1,2} Clinical signs of COVID-19 infection include fever, cough, shortness of breath, and breathing difficulties, with severe cases potentially leading to pneumonia, multi-organ failure, and death. The incubation period ranges from 1 to 14 days, primarily 5-6 days, and asymptomatic transmission is possible.²

Sub-Saharan Africa experienced a relatively delayed onset of the pandemic, with Nigeria reporting its first case in late February 2020.³ Despite early implementation of preventive measures, the virus spread significantly; by mid-August 2020, Africa had recorded over one million cases and more than 24,000 deaths.⁴ Nigeria emerged as one of the top 10 African countries with high incidence rates.⁵ By late June 2020, Bauchi State in North-East Nigeria had recorded approximately 500 cases, with a notable proportion among children.⁶

Globally, the World Health Organization (WHO) reported over 5.8 million cases and more than 360,000 deaths by May 30, 2020.⁵ In the early stages of the outbreak in China, 18.5% of patients developed severe disease characterized by acute respiratory distress syndrome and septic shock.⁷ The pandemic's socioeconomic impact has been profound,

with surveys indicating that over two-thirds of African populations risked food shortages and half would deplete their savings within a week of lockdown.⁸

Sub-Saharan African countries face particular vulnerability due to fragile health systems resulting from conflicts, delayed post-military reforms, corruption, and healthcare worker emigration.^{9,10} Nigeria exemplifies these challenges, ranking poorly in healthcare system integrity among Anglophone West African countries.¹¹ Political transitions frequently change health ministry leadership, often without consideration of technical competence, while funds allocated for healthcare reform face diversion, and government officials frequently engage in medical tourism.¹² These systemic issues contribute to a high burden of chronic diseases, predisposing populations to severe COVID-19 outcomes.¹³

The pandemic's impact has been particularly acute in North-East Nigeria, a region already grappling with insecurity, violence, and social exclusion following over a decade of conflict. By March 2020, approximately 7.9 million people in the region required life-saving assistance, including internally displaced persons and individuals with disabilities.¹⁴

Non-pharmaceutical interventions (NPIs) have proven effective in reducing SARS-CoV-2 transmission across various contexts.¹⁵⁻¹⁸ These measures include social distancing, school closures, travel restrictions, and face mask use in public spaces. Beyond COVID-19, NPIs may also reduce transmission of other respiratory infections.^{19,20} Understanding the impact of NPI implementation on these infections remains crucial for assessing broader public health implications, particularly when considering relaxation of such measures.

Africa possesses certain demographic and climatic advantages in managing the pandemic. As the world's youngest continent with a median age below 20 years, Africa's population may experience milder disease manifestations compared to older populations.^{4,21} Early data from China indicated that most COVID-19 deaths occurred among adults aged 60 years and above or those with underlying health conditions. Only 3% of sub-Saharan Africa's population exceeds 65 years, compared to approximately 12% in China. Climatic factors, particularly air temperature, may also influence viral transmission patterns, with respiratory viruses typically spreading more readily during cold rainy seasons.⁴

In Nigeria, the Federal Ministry of Health, in collaboration with the Nigeria Centre for Disease Control (NCDC) and the National Primary Health Care Development Agency, implemented comprehensive risk communication strategies.²² These included cascade training for health facility workers, traditional leaders, and religious leaders on public health messaging, case identification, and reporting protocols.²² The National Emergency Operations Centre, supported by partners, coordinated response activities and strengthened preparedness capacity nationwide.²³

Nigeria demonstrated early preparedness by initiating planning approximately one week after China's initial case reports, drawing on experiences from previous epidemics including Ebola, Polio, and Lassa fever.^{24,25} Significant financial investments were made in preparedness and surveillance through federal initiatives and the Nigerian Private Sector Coalition Against COVID-19.²⁶ The Presidential Task Force on COVID-19 coordinated daily reviews of national response strategies and implementation activities. Deployed NPIs included stay-at-home orders, travel restrictions, border controls, rapid response teams, health

worker training, intensified risk communication, enhanced surveillance, case identification, isolation protocols, diagnosis, contact tracing, and monitoring of persons of interest.^{27,28} This study aimed to assess knowledge, attitude, and practice regarding non-pharmaceutical preventive measures for COVID-19 among residents of Tafawa Balewa LGA, Bauchi State.

Methodology

Study Area

The study was conducted in Tafawa Balewa Local Government Area (LGA), located in the southern part of Bauchi State, North-east, Nigeria, at latitude 9°45'21.77"N and longitude 9°33'22.4"E. The LGA headquarters is situated in Bununu town. Tafawa Balewa borders Plateau State to the southwest, Bogoro LGA to the south, Gombe State to the east, Alkaleri LGA to the northeast, Bauchi and Dass LGAs to the north, and Toro LGA to the northwest. The name "Tafawa Balewa" derives from two corrupted Fulani words: "Tafari" (rock) and "Baleri" (black). The area has historically experienced sectarian and ethnic violence, leading to relocation of the LGA secretariat from Tafawa Balewa town to Bununu. Major ethnic groups include the Sayawa (majority in towns and surrounding villages) and Hausawa/Fulani, with traditional rulers predominantly from the Muslim Fulani ethnic group. Districts within the LGA include Tafawa Balewa, Bununu, Bula, Danjiri, Dull, Kardam A, Kardam B, Lere South, Lere North, Tapshin, and Ball.

According to the 2006 National Population Census, Tafawa Balewa LGA had a population of 219,988. Using national population growth rates for 2007-2020, the projected population for 2020 was 318,113.²⁹ The region's primary economic activities are farming and trading. Educational infrastructure includes numerous primary and secondary schools, with the National Open University of Nigeria as the major tertiary institution. Two

secondary health facilities are located in Tafawa Balewa and Boto towns, complemented by numerous primary health centers and clinics across all wards and settlements.

Study Design

A descriptive cross-sectional study design was employed for this study.

Study Population

The study population comprised residents of Tafawa Balewa LGA aged 18 years and above who consented were included and those that were critically ill or absent during data collection were excluded.

Sample Size Determination

Sample size was calculated using Fisher's formula:

$$n = Z^2pq/d^2$$

Where:

- n = minimum sample size required
- Z = standard normal deviate at 95% confidence level = 1.96
- d = desired precision = 5% (0.05)
- p = 22% (0.22) from previous studies³¹
- q = $1-p$ = 0.78

$$\begin{aligned} n &= (1.96)^2 \times (0.22 \times 0.78) / (0.05)^2 \\ n &= 3.8416 \times 0.1716 / 0.0025 \\ n &= 0.6592 / 0.0025 \\ n &= 263.68 \approx 264 \end{aligned}$$

To account for anticipated non-response, the minimum sample was increased by 10%:
 $n = 264 + (10/100 \times 264) = 264 + 26.4 = 290.4 \approx 290$ respondents

Sampling Technique

A multi-stage sampling technique was implemented as follows:

Stage 1: Selection of LGA

One LGA was selected using simple random sampling by balloting.

Stage 2: Selection of Wards

Four wards were selected using simple random sampling by balloting, the selected wards are as follows:

1. Dull Ward
2. Lere North Ward
3. Morno Ward
4. Kardam Ward

Stage 3: Selection of Settlements

Four settlements were selected from each selected ward using simple random sampling by balloting:

Ward	Settlements
Dull	Taki, Budbin, Targal, Dutsen Gogu
Lere North	Lere, Sikdi, Shehu, Maigemu
Morno	Kwabtin Rimi, Zari, Daranji, Karwasa
Kardam	Kardam, Mursum, Kundum, Tarji

Stage 4: Selection of households

House numbering was conducted in selected settlements. The total population of each settlement was determined, and proportionate allocation of questionnaires was performed based on settlement population. Sampling intervals were calculated using respective settlement sample sizes and populations. The first household was determined using a random number table.

Stage 5: Selection of Respondents

. Respondent that satisfied the criteria was interviewed. A total of 290 questionnaires were administered

Study Instrument

Data were collected using semi-structured, interviewer-administered questionnaires comprising both closed-ended (multiple choice) and open-ended questions. The questionnaire was organized into four sections:

Section A: Socio-demographic characteristics of respondents

Section B: Knowledge of non-pharmaceutical COVID-19 preventive measures

Section C: Attitudes toward non-pharmaceutical COVID-19 preventive measures

Section D: Practices regarding non-pharmaceutical COVID-19 preventive measures

Data Collection Methods

Pre-tested (10%) of the questionnaire, interviewer-administered questionnaires were utilized for data collection. The questionnaire was pre-tested in a non-selected ward to assess clarity, relevance, and feasibility, with necessary modifications made before final administration.

Data Management and Analysis

Measurement of Variables

Dependent Variables: Knowledge, attitude, and practice regarding non-pharmaceutical COVID-19 preventive measures.

Independent Variables: Age, sex, occupation, educational status, marital status, ethnicity.

Statistical Analyses

Data were analyzed using SPSS version 26.0. The following statistical tools were employed:

Frequency distributions and simple percentages; Mean scores and standard deviations; Pearson's correlation coefficient for the relationship between knowledge and practice (significance set at $p < 0.05$); while knowledge, attitude, and practice scores were categorised as "good" or "poor" based on mean scores. Respondents scoring above the mean were classified as having good

knowledge/attitude/practice, while those scoring below the mean were classified as having poor knowledge/attitude/practice.

Ethical Considerations

Ethical clearance was obtained from the Health Research Ethics Committee of Ministry of Health. Permission was secured from the head of each selected ward. All data collected were treated with utmost confidentiality. Signed or thumb-printed informed consent was obtained from all respondents prior to participation.

Results

All 290 distributed questionnaires were completed and returned, yielding a 100% response rate.

Socio-Demographic Characteristics of the Respondents

Table 1: Socio-Demographic Characteristics of the Respondents (n=290)

Characteristics	Frequency (n)	Percentage (%)
Age Group		
18-30 years	114	39.3
31-60 years	148	51.0
61-80 years	28	9.7
Mean Age $\pm$ SD	38.6 $\pm$ 12.4 years	
Religion		
Islam	188	64.8
Christianity	102	35.2
Gender		
Male	190	65.5
Female	100	34.5

Characteristics	Frequency (n)	Percentage (%)
Marital Status		
Single	94	32.4
Married	169	58.3
Divorced	13	4.5
Widowed	14	4.8
Occupation		
Civil Servant	70	24.1
Farmer	100	34.5
Business/Trader	83	28.6
Housewife	30	10.3
Others	7	2.4
Ethnicity		
Hausa	98	33.8
Fulani	60	20.7
Sayawa	68	23.4
Jarawa	62	21.4
Others	2	0.7
Total	290	100

Table 1 shows that the majority of respondents (51.0%) were aged 31-60 years, with a mean age of 38.6 ± 12.4 years. Only 9.7% were above 60 years. Most respondents were Muslims (64.8%), male (65.5%), and married (58.3%). Farming was the predominant occupation (34.5%), followed by business/trading (28.6%). The Hausa ethnic group constituted the largest proportion (33.8%), followed by Sayawa (23.4%), Jarawa (21.4%), and Fulani (20.7%).

Knowledge of Non-Pharmaceutical Preventive Measures of COVID-19

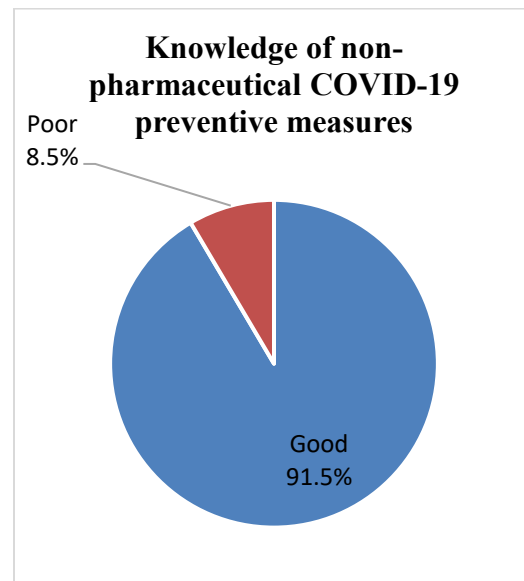


Figure 1: Knowledge Score Distribution

Figure 1 illustrates that the vast majority of respondents (91.7%) demonstrated good knowledge of non-pharmaceutical COVID-19 preventive measures, while only 8.3% exhibited poor knowledge.

Table 2: Knowledge of Non-Pharmaceutical COVID-19 Preventive Measures (n=290)

Variable	Frequency (n)	Percentage (%)
Heard about non-pharmaceutical measures of COVID-19?		
Yes	281	96.9
No	9	3.1
Source of information (n=281)		
Radio	100	35.6
Television	71	25.3
Health Care Facility	35	12.5

Variable	Frequency (n)	Percentage (%)
Friends/Relatives	54	19.2
Other sources	21	7.5
Know importance of non-pharmaceutical measures?		
Yes	261	90.0
No	9	3.1
Not sure	20	6.9
Types of non-pharmaceutical measures known*		
Use of face mask	100	34.5
Social distancing	80	27.6
Hand sanitizer use	35	12.1
Hand washing	54	18.6
Other measures	21	7.2
Is hand washing important?		
Yes	281	96.9
No	9	3.1
Recommended hand washing duration		
Less than 20 seconds	20	6.9
20 seconds to 1 minute	52	17.9
1 minute to 1 minute 30 seconds	209	72.1
Not applicable	9	3.1
Total	290	100

*Multiple responses

Table 2 reveals that 96.9% of respondents had heard about non-pharmaceutical

COVID-19 prevention measures, primarily through radio (35.6%). The majority (90.0%) understood the importance of these measures. Regarding specific NPIs, face mask use (34.5%) was most frequently mentioned, followed by social distancing (27.6%). Almost all respondents (96.9%) acknowledged the importance of hand washing, and 72.1% correctly identified the recommended hand washing duration of 1 minute to 1 minute 30 seconds.

Attitude toward Non-Pharmaceutical Preventive Measures of COVID-19

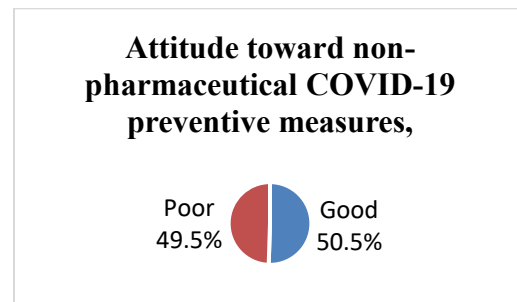


Figure 2: Attitude Score Distribution

Figure 2 demonstrates that slightly over half (50.5%) of respondents exhibited a positive attitude toward non-pharmaceutical COVID-19 preventive measures, while 49.5% demonstrated a negative attitude.

Table 3: Attitude toward Non-Pharmaceutical COVID-19 Preventive Measures (n=290)

Variables	Frequency (n)	Percentage (%)
Perception of non-pharmaceutical measures		
Can prevent COVID-19 infection	159	54.8
Against my religion	34	11.7
Against my culture	26	9.0

Variables	Frequency (n)	Percentage (%)
Feel discomfort when practicing	71	24.5
Protective measures against COVID-19*		
Proper hygiene (hand washing)	111	38.3
Social distancing	98	33.8
Use of face mask	56	19.3
Prayer	25	8.6
Other measures	0	0
Is social distancing effective?		
Yes	197	67.9
No	93	32.1
Who should wear face masks?		
Everyone	56	19.3
Only sick people	134	46.2
Health workers only	77	26.6
Suspected persons only	20	6.9
Others	3	1.0
Complying with government stay-at-home order?		
Yes	52	17.9
No	226	77.9
Maybe	12	4.1
Should people avoid crowded areas?		
Yes	123	43.4
No	167	56.6

Variables	Frequency (n)	Percentage (%)
Crowded areas to avoid (n=123)*		
Church	23	18.7
Mosque	14	11.4
Market	44	35.8
Hospital	33	26.8
Night club	9	7.3
Total	290	100

*Multiple responses

Table 3 indicates that 54.8% of respondents perceived NPIs as effective for COVID-19 prevention. However, 24.5% reported discomfort when practicing these measures, while 11.7% and 9.0% cited religious and cultural barriers, respectively. Hand washing (38.3%) was most frequently identified as protective, followed by social distancing (33.8%). Although 67.9% acknowledged social distancing's effectiveness, only 43.4% agreed that crowded areas should be avoided. Notably, 46.2% believed that only sick people should wear face masks, and 77.9% reported non-compliance with government stay-at-home orders.

Practice of Non-Pharmaceutical Preventive Measures of COVID-19

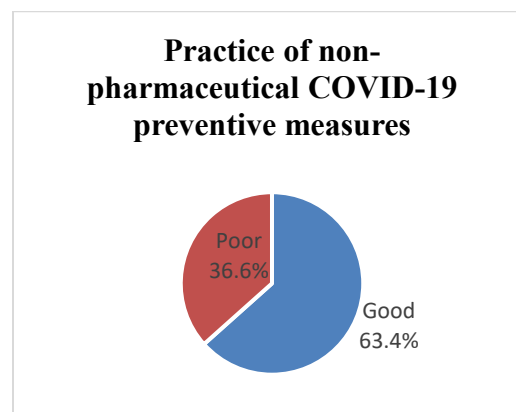


Figure 3: Practice Score Distribution

Figure 3 illustrates that 63.4% of respondents demonstrated good practice of non-pharmaceutical COVID-19 preventive measures, while 36.6% exhibited poor practice.

Table 4: Practice of Non-Pharmaceutical COVID-19 Preventive Measures (n=290)

Variable	Frequency (n)	Percentage (%)
Ever used/practiced any non-pharmaceutical measure?		
Yes	200	69.0
No	87	30.0
Not sure	3	1.0
Type of measure practiced (n=200)*		
Face mask use	77	38.5
Hand washing	58	29.0
Hand sanitizer use	50	25.0
Social distancing	75	37.5
Other measures	0	0
Complying with government stay-at-home order?		
Yes	80	27.6
No	157	54.1
Maybe	53	18.3
Agree with obligatory lockdown measures?		
Yes	80	27.6
No	188	64.8
Maybe	22	7.6

Variable	Frequency (n)	Percentage (%)
Follow NCDC/FMOH recommendations during social distancing?		
Yes	188	64.8
No	102	35.2
Sometimes	0	0
Total	290	100

***Multiple responses**

Table 4 shows that 69.0% of respondents reported having practiced at least one non-pharmaceutical measure. Among these, face mask use (38.5%) and social distancing (37.5%) were most commonly practiced. However, only 27.6% reported complying with government stay-at-home orders, and 64.8% disagreed with obligatory lockdown measures. Notably, 64.8% indicated following NCDC or Federal Ministry of Health recommendations during social distancing.

Relationship between Knowledge and Practice**Table 5: Correlation between Knowledge and Practice Scores**

Measure	Value	Asymptotic Standard Error	Approximate T	Approximate Significance
Pearson's R	0.947	0.022	5.093	0.015
Spearman Correlation	0.884	0.062	3.273	0.047

Table 5 reveals a statistically significant positive correlation between knowledge and practice scores (Pearson's $R = 0.947$, $p = 0.015$). The correlation coefficient approaching 1 indicates a strong association, leading to rejection of the null hypothesis and acceptance of the alternative hypothesis that a significant relationship exists between knowledge and practice of non-pharmaceutical COVID-19 preventive measures.

Discussion

This community-based cross-sectional study assessed knowledge, attitude, and practice regarding non-pharmaceutical COVID-19 preventive measures among residents of Tafawa Balewa LGA, Bauchi State, Nigeria. The findings provide valuable insights into community preparedness and response to the pandemic in a resource-limited setting.

The study revealed high awareness (96.9%) of non-pharmaceutical COVID-19 measures, consistent with findings from other African settings.^{33,35} Radio emerged as the predominant information source (35.6%), reflecting its accessibility and reach in rural Nigerian communities. This aligns with previous research indicating that mass media, particularly radio, plays a crucial role in health communication in low-resource settings.³⁶ Health facilities contributed modestly (12.5%) as information sources, suggesting opportunities for strengthening facility-based health education.

The high proportion of respondents with good knowledge (91.7%) is encouraging and comparable to findings from Ethiopia (85.7%)³⁵ and China (90%).³³ This likely reflects the intensive risk communication campaigns implemented by Nigerian health authorities.^{22,23} Most respondents correctly identified face mask use, social distancing, and hand hygiene as key preventive measures, with 72.1% accurately recognizing the recommended hand washing duration of at least one minute. This knowledge level suggests effective message

dissemination, though the 27.9% who underestimated the required duration indicate a need for continued education.

Despite good knowledge, attitude scores revealed important disparities. While 54.8% perceived NPIs as effective, substantial proportions cited religious (11.7%) and cultural (9.0%) barriers, or discomfort with practice (24.5%). These findings echo studies from Northern Nigeria where religious and cultural beliefs influenced COVID-19 prevention perceptions.³⁷ The proportion believing that only sick people should wear masks (46.2%) contradicts WHO and NCDC recommendations for universal masking in public spaces,^{38,39} highlighting a critical knowledge-practice gap requiring targeted health education.

Compliance with government stay-at-home orders was notably low (17.9%), and 64.8% disagreed with obligatory lockdown measures. This finding is consistent with studies from sub-Saharan Africa where economic necessity often overrides public health directives.^{40,41} The region's high poverty rates and reliance on daily income for survival make sustained lockdowns impractical for many households.^{8,42} This underscores the need for balanced public health interventions that consider socioeconomic realities and provide adequate support for vulnerable populations during movement restrictions.

The proportion of respondents reporting good practice (63.4%) is moderate but lower than knowledge levels, indicating a knowledge-practice gap common in health behaviour studies.^{34,43} The statistically significant correlation between knowledge and practice ($p = 0.015$) suggests that improved knowledge contributes to better practice, supporting continued investment in health education. However, the gap between knowledge and practice indicates that education alone is insufficient; addressing structural, economic, and social barriers is essential.

Face mask use (38.5%) and social distancing (37.5%) were the most commonly practiced measures, while hand sanitizer use (25.0%) was less frequent. This likely reflects limited access to alcohol-based hand sanitizers in rural communities, as many respondents reported hearing about sanitizers without ever seeing them. This finding highlights the need for governments and partners to ensure equitable distribution of preventive supplies, particularly in underserved areas.

The low compliance with stay-at-home orders (27.6%) and disagreement with lockdown measures (64.8%) align with findings from other African studies.^{44, 45} Murphy et al.⁴⁶ found that compliance with COVID-19 restrictions was influenced by perceived duty rather than self-interest, suggesting that fostering collective responsibility may enhance adherence. In the Nigerian context, trust in government and health systems emerged as a critical factor, consistent with research showing that institutional trust significantly influences public health compliance.⁴⁷

The relationship between socio-demographic factors and KAP warrants attention. Younger age and higher education levels appeared associated with better understanding, consistent with previous studies.^{48, 49} This suggests the need for tailored interventions targeting older adults and those with limited formal education. The predominance of male respondents (65.5%) may reflect cultural norms regarding household representation but could limit generalizability to female perspectives.

Comparing these findings with other Nigerian studies, Habib et al.³⁷ reported similar knowledge levels in Northern Nigeria but found higher compliance with preventive measures, possibly reflecting urban-rural differences or temporal variations in pandemic phases. Hager et al.⁵⁰ documented comparable KAP patterns across multiple African countries, noting that misinformation and misconceptions

remained significant challenges despite high awareness.

The finding that 24.5% reported discomfort with NPIs aligns with research on the psychosocial impact of pandemic restrictions.^{51, 52} Prolonged implementation of measures like social distancing may cause fatigue, anxiety, or social isolation, particularly in collectivist cultures where social connections are highly valued. This suggests that public health messaging should acknowledge these challenges while promoting adaptive strategies for maintaining social connections safely.

Limitations of the Study

The followings limitations should be considered when interpreting these findings. First, the cross-sectional design captures data at a single time point, limiting inference about causal relationships or changes over time. Second, reliance on self-reported practices may introduce social desirability bias, potentially overestimating compliance. Third, the study's focus on a single LGA limits generalizability to other regions with different socio-demographic profiles. Finally, the study was conducted during the pandemic's earlier phases; knowledge, attitudes, and practices may have evolved with subsequent waves, new information, and vaccine introduction.

Conclusions

This study demonstrates that residents of Tafawa Balewa LGA exhibited good knowledge, attitude, and practice regarding COVID-19 NPIs; significant gaps existed between knowledge and consistent implementation, particularly regarding compliance with stay-at-home orders and lockdown measures. The study identified important barriers to NPI adherence, including religious and cultural beliefs, physical discomfort, economic necessity, and limited access to preventive supplies such as hand sanitizers. Younger age and higher education levels were associated with better understanding and compliance. The significant correlation between knowledge

and practice supports continued health education, but findings emphasize that education alone cannot overcome structural barriers. The study highlights the influence of socioeconomic factors, perceptions, and trust in government on adherence to public health interventions.

References

1. Deborah J. Perception of Undergraduate Students on the Impact of COVID-19 Pandemic on Higher Institutions Development in Federal Capital Territory Abuja, Nigeria. Apr-Jun 2020. (Accessed on April, 2020).
2. Impact of the 2019-20 coronavirus pandemic on education, 2020. (Accessed on April 2020)
3. Nigeria Centre for Disease Control. First case of coronavirus disease confirmed in Nigeria. Abuja: NCDC; 2020.
4. Africa CDC. COVID-19 update. 2020. Available from: <https://africacdc.org/covid-19/>
5. World Health Organization. Coronavirus disease (COVID-19) Situation Report-120. Geneva: WHO; 2020. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>
6. Nigeria Centre for Disease Control. COVID-19 Nigeria. Abuja: NCDC; 2020.
7. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. Chinese Journal Epidemiology. 2020;41(1):145-51.
8. Africa CDC. Most Africans will go hungry in 14 day lockdown. 2020. Available from: <https://www.bbc.com/news/world-africa-52557464>
9. Gherghel I, Bulai M. Is Romania ready to face the novel coronavirus (COVID-19) outbreak? The role of incoming travelers and that of Romanian diaspora. Travel Med Infect Dis. 2020;101628.
10. Olu-Owolabi EF, Wogu IAP, Azogu AF, Emmanuel HO, Ezeji A, Misra S, et al. The mass media, migration issues, and the brain drain nexus: Implications for political development in 21st century Nigeria. In: Handbook of Research on the Global Impact of Media on Migration Issues. 1st ed. Hershey: IGI Global; 2020.
11. Onwujekwe O, Agwu P, Orjiakor C, Mckee M, Hutchinson E, Mbachu C, et al. Corruption in Anglophone West Africa health systems: A systematic review of its different variants and the factors that sustain them. Health Policy Plan. 2019;34:529-43.
12. Adeloye D, David RA, Olaogun AA, Auta A, Adesokan A, Gadanya M, et al. Health workforce and governance: The crisis in Nigeria. Hum Resour Health. 2017;15:32.
13. Ibrahim AS, Lanhui W, Habibi SMG. An analysis on the causes and effects of recent economic recession on the Nigerian economy. J Soc Sci Humanit. 2018;6:453-63.
14. United Nations Office for the Coordination of Humanitarian Affairs. Humanitarian Response Plan: Nigeria. March 2020:12.
15. Pei S, Kandula S, Shaman J. Differential effects of intervention timing on COVID-19 spread in the United States. medRxiv. 2020;10.1101/2020.05.15.20103655.
16. Tian H, Liu Y, Li Y, Wu CH, Chen B, Kraemer MUG, et al. An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China. Science. 2020; 368:638-42.
17. Lai S, Ruktanonchai NW, Zhou L, Prosper O, Luo W, Floyd JR, et al. Effect of non-pharmaceutical interventions to contain COVID-19 in China. Nature. 2020; 585:410-3.
18. Chinazzi M, Davis JT, Ajelli M, Gioannini C, Litvinova M, Merler S, et al. The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. Science. 2020; 368:395-400.
19. Leung NH, Chu DK, Shiu EY, Chan KH, McDevitt JJ, Hau BJ, et al. Respiratory virus

- shedding in exhaled breath and efficacy of face masks. *Nat Med.* 2020; 26:676-80.
20. Cowling BJ, Ali ST, Ng TW, Tsang TK, Li JC, Fong MW, et al. Impact assessment of non-pharmaceutical interventions against coronavirus disease 2019 and influenza in Hong Kong: An observational study. *Lancet Public Health.* 2020;5:e279-88.
 21. Africa CDC. COVID-19: Update in Africa, 25 March 2020. Twitter. Available from: <https://twitter.com/AfricaCDC/status/1242724814458105857>
 22. Amzat J, Aminu K, Kolo VI, Akinyele AA, Ogundairo JA, Danjibo MC. Coronavirus outbreak in Nigeria: Burden and socio-medical response during the first 100 days. *Int J Infect Dis.* 2020; 98:218-24.
 23. Nigeria Centre for Disease Control. COVID-19 outbreak in Nigeria situation report 19th March 2020. Abuja: NCDC; 2020:1-3.
 24. Unah L. Nigeria will deal with this: High alert after coronavirus case. *Al Jazeera.* 2020. Available from: <https://www.aljazeera.com/news/2020/03/deal-high-alert-coronavirus-case-200301140838366.html>
 25. Kapata N, Ihekweazu C, Ntoumi F, Raji T, Chanda-Kapata P, Mwaba P, et al. Is Africa prepared for tackling the COVID-19 (SARS-CoV-2) epidemic? Lessons from past outbreaks, ongoing pan-African public health efforts, and implications for the future. *Int J Infect Dis.* 2020. Available from: <https://doi.org/10.1016/j.ijid.2020.02.049>
 26. Gilbert M, Pullano G, Pinotti F, Valdano E, Poletto C, Boëlle PY, et al. Preparedness and vulnerability of African countries against importations of COVID-19: A modelling study. *Lancet.* 2020;395. Available from: [https://doi.org/10.1016/S0140-6736\(20\)30411-6](https://doi.org/10.1016/S0140-6736(20)30411-6)
 27. Nigerian Television Authority. Breakdown of contributions to fight COVID-19 in Nigeria. 2020. Available from: <https://www.nta.ng/news/finance/20200402-breakdown-of-contributions-to-fight-covid19-nigeria-cbn/>
 28. Nigeria Centre for Disease Control. NCDC initiates new measures for pandemic control as COVID-19 spreads to 12 states in Nigeria. Abuja: NCDC; 2020.
 29. National Population Commission. Nigeria Demographic and Health Survey 2018. Abuja: NPC; 2019.
 30. Centers for Disease Control and Prevention. Coronavirus Disease 2019 (COVID-19): FAQ on hand hygiene. Atlanta: CDC; 2020. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/hcp-hand-hygiene-faq.html>
 31. Centers for Disease Control and Prevention. Hand hygiene in healthcare settings. Atlanta: CDC; 2019. Available from: <https://www.cdc.gov/handhygiene/index.html>
 32. Zhong B, Luo W, Li H, Zhang Q, Liu X, Li W, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: A quick online cross-sectional survey. *Int J Biol Sci.* 2020;16(10):1745-52.
 33. Elnadi H, Odetokun IA, Bolarinwa O, Zainab A, Okechukwu O, Al-Mustapha AI. Knowledge, attitude, and perceptions towards the 2019 Coronavirus Pandemic: A bi-national survey in Africa. *PLoS ONE.* 2020;15(7):e0236918.
 34. Bekele D, Tolossa T, Tsegaye R, Teshome W. The knowledge and practice towards COVID-19 pandemic prevention among residents of Ethiopia: An online cross-sectional study. 2020.
 35. Masoud AT, Zaazouee MS, Elsayed SM, Ragab KM, Kamal EM, Alnasser YT, et al. KAP-COVIDGLOBAL: A multinational survey of the levels and determinants of public knowledge, attitudes and practices

- towards COVID-19. *BMJ Open*. 2021;11:e043971.
36. Kakemam E, Ghoddoosi-Nejad D, Chegini Z, Momeni K, Salehiniya H, Hassanipour S, et al. Knowledge, attitudes, and practices among the general population during COVID-19 outbreak in Iran: A national cross-sectional online survey. *Front Public Health*. 2020;8.
 37. Habib MA, Dayyab FM, Iliyasu G, Habib AG. Knowledge, attitude and practice survey of COVID-19 pandemic in Northern Nigeria. *PLoS ONE*. 2021;16(1):e0245176.
 38. World Health Organization. Advice on the use of masks in the context of COVID-19. Geneva: WHO; 2020. Available from: [https://www.who.int/publications-detail/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-\(2019-ncov\)-outbreak](https://www.who.int/publications-detail/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak)
 39. Nigeria Centre for Disease Control. Advisory on the use of masks by members of the public without respiratory symptoms. Abuja: NCDC; 2020. Available from: <https://covid19.ncdc.gov.ng/resource/guideline/UseOfMasks.pdf>
 40. Nwafor JI, Aniukwu JK, Anozie BO, Ikeotuonye AC. Knowledge and practice of preventive measures against COVID-19 infection among pregnant women in a low-resource African setting. *medRxiv*. 2020.
 41. Akim AM, Ayivodji F. Interaction effect of lockdown with economic and fiscal measures against COVID-19 on social-distancing compliance: Evidence from Africa. Available from: <https://ssrn.com/abstract=3621693>
 42. World Health Organization. Strategic preparedness and response plan for the novel coronavirus. Geneva: WHO; 2020. Available from: <https://www.who.int/publications-detail/strategic-preparedness-and-response-plan-for-the-new-coronavirus>
 43. Lee M, Kang BA, You M. Knowledge, attitudes, and practices (KAP) toward COVID-19: A cross-sectional study in South Korea. *BMC Public Health*. 2021; 21:1-10.
 44. Nivette A, Ribeaud D, Murray A, Steinhoff A, Bechtiger L, Hepp U, et al. Non-compliance with COVID-19-related public health measures among young adults in Switzerland: Insights from a longitudinal cohort study. *Soc Sci Med*. 2021; 268:113370.
 45. Nigerian Health Watch. Coronavirus: Time to take social distancing seriously in Nigeria. 2020.
 46. Murphy K, Williamson H, Sargeant E, McCarthy M. Why people comply with COVID-19 social distancing restrictions: Self-interest or duty? *Aust N Z J Criminol*. 2020; 53:477-96.
 47. The Irish Times. The cluster effect: How social gatherings were rocket fuel for coronavirus. 2020. (Accessed on April, 2020).
 48. The US Sun Newspaper. Mardi Gras blamed for coronavirus outbreak in Louisiana as New Orleans looks set to be next epicenter. 2020. (Accessed on April, 2020).
 49. Feng S, Shen C, Xia N, Song W, Fan M, Cowling BJ. Rational use of face masks in the COVID-19 pandemic. *Lancet Respir Med*. 2020;8:434-6.
 50. Hager E, Odetokun IA, Bolarinwa O, Zainab A, Okechukwu O, Al-Mustapha AI. Knowledge, attitude, and perceptions towards the 2019 Coronavirus Pandemic: A bi-national survey in Africa. *PLoS ONE*. 2020;15(7):e0236918.
 51. Abel T, McQueen D. The COVID-19 pandemic calls for spatial distancing and social closeness: Not for social distancing! *Int J Public Health*. 2020; 65:231.
- Kim S, Su K. Using psychoneuroimmunity against COVID-19. *Brain Behav Immun*. 2020.

Assessment of quality of life and risk of fall among stroke survivors in selected hospitals in Maiduguri, Borno state

Muhammad Audu Dan-Inu¹, Abubakar Baba Saleh¹, Auwal Shitu¹, Yunusa Usman Muhammad².

¹Department of physiotherapy, College of medical Sciences, Yobe state university, Damaturu,

²Department of physiotherapy, Yobe State University Teaching Hospital, Damaturu.

Corresponding Author: Dan-Inu Muhammad Audu, Email: daninumuhd@ysu.edu.ng

<https://dx.doi.org/10.4314/yomj.v2i2.3>

Received: 31-Dec-2025

Accepted: 24-Aug-2026

Published: 31-Aug-2026

ABSTRACT

Background: Stroke remains a major cause of long-term disability worldwide, affecting physical, psychological, and social functioning. In Nigeria, stroke survivors frequently experience reduced quality of life (QoL) and heightened fall risk due to persistent impairments and limited access to rehabilitation services. The interplay between these outcomes remains underexplored in Northern Nigeria, particularly in conflict-affected regions.

Objective: To assess the quality of life and risk of fall among stroke survivors in selected hospitals in Maiduguri, Borno State.

Materials and Methods: A cross-sectional survey was conducted among 62 stroke survivors recruited using convenience sampling from Umaru Shehu Ultra-Modern Hospital and the University of Maiduguri Teaching Hospital. Socio-demographic and clinical data were collected using a structured questionnaire. Fall risk was assessed using the Falls Risk Assessment Tool (FRAT), while QoL was measured using the Stroke-Specific Quality of Life Scale (SS-QoL). Data were analyzed using descriptive statistics and Chi-square tests, with significance set at $p < 0.05$.

Results: Participants included 32 males (51.6%) and 30 females (48.4%), with the majority aged 51–60 years (33.9%). QoL scores varied across domains, with no significant association between overall QoL and fall risk ($\chi^2 = 450.352$, $df = 432$, $p = 0.262$). However, a significant linear trend was observed between QoL and fall risk (Linear-by-Linear Association = 7.058, $p = 0.008$). Age, gender, educational level, and post-stroke duration were significantly associated with selected QoL domains ($p < 0.05$). No socio-demographic variable showed a significant association with fall risk.

Conclusion: No statistically significant association was found between overall QoL and fall risk among stroke survivors. However, specific socio-demographic factors significantly influenced QoL domains. Rehabilitation programs should target modifiable determinants of QoL while implementing fall prevention strategies for at-risk survivors.

Keywords: Stroke, Quality of Life, Fall Risk, Stroke Survivors, Maiduguri

Cite this article: Dan-Inu MA, Saleh AB, ShituA, Muhammad YU. Assessment of quality of life and risk of fall among stroke survivors in selected hospitals in Maiduguri, Borno state. Yob Med J.2026;2(2):102-115

Introduction

Stroke remains a leading cause of long-term disability and mortality globally, with profound impacts on physical, psychological, and social functioning [1,2]. The global burden of stroke has continued to rise, with low- and middle-income countries (LMICs) bearing a disproportionate share of the disease burden. In Sub-Saharan Africa, the prevalence of stroke has been reported at 4.3 per 1,000 population, with Nigeria contributing significantly to this burden [3]. Recent modeling studies from Nigeria have demonstrated that stroke prevalence is high and predicted to rise, with projections indicating a 29.63% increase by December 2022 and 36.67% by December 2023 [4]. The consequences of stroke include balance impairment, muscle weakness, cognitive decline, reduced quality of life, and significantly increased risk of falls [5,6].

Quality of life (QoL) among stroke survivors has been extensively studied, with evidence consistently demonstrating reduced QoL compared to the general population [7]. In Nigeria, recent research has shown that resilience significantly influences QoL across the first post-stroke year, with higher resilience associated with improved QoL over time [8]. A study conducted at the University of Ilorin Teaching Hospital specifically assessed the relationship between stroke severity and health-related quality of life (HRQoL) among Nigerian stroke survivors, revealing that stroke severity inversely correlates with QoL outcomes [9]. Similarly, research from the University of Maiduguri Teaching Hospital has documented the functional outcomes and QoL challenges faced by stroke survivors in the region [10].

Falls represent a major complication of stroke, contributing substantially to morbidity, mortality, and healthcare costs. Globally, falls account for over 684,000 deaths annually, with stroke survivors being

particularly vulnerable due to impaired postural control, muscle weakness, and neurological deficits [11]. Recent prospective cohort evidence demonstrates that falls affect over 30% of stroke survivors within the first year post-stroke [12]. Among chronic stroke patients, falls occur most frequently during walking (38.5%), with 46.5% of first falls occurring within 2-6 months post-stroke. Furthermore, over 54% of falls lead to consequences such as fractures, ligament strains, bruises, or abrasions, significantly impacting QoL and functional independence [13]. Research has demonstrated that self-help activities, social roles, and upper extremity function are significantly lower in the fall group among chronic stroke patients ($p < 0.05$), indicating the far-reaching consequences of falls on overall well-being [14].

In Nigeria, approximately 23% of adults report experiencing falls, and stroke survivors are particularly vulnerable due to persistent impairments [15]. The interplay between QoL and fall risk in stroke survivors is complex and multifactorial. Studies have reported that falls are significantly associated with reduced life satisfaction among hospitalized stroke patients (OR = 0.77, 95% CI: 0.61-0.98, $p = 0.0325$), highlighting the critical relationship between fall events and overall QoL [16]. However, the simultaneous assessment of both QoL and fall risk among stroke survivors in Northern Nigeria, particularly in conflict-affected regions, remains limited.

Maiduguri, the capital of Borno State, presents unique challenges that may influence stroke recovery outcomes. The region has been affected by prolonged conflict, which has disrupted healthcare infrastructure, limited access to rehabilitation services, and created socio-economic stressors that may compound the burden of stroke. These contextual factors make understanding QoL and fall risk particularly

important for planning targeted, contextually appropriate rehabilitation interventions.

Despite the high prevalence of stroke-related disability and the unique challenges in Maiduguri, limited studies have examined both fall risk and QoL simultaneously in this population. This study, therefore, assessed the quality of life and risk of fall among stroke survivors in selected hospitals in Maiduguri, Borno State.

Materials and Methods

Study Design

A cross-sectional survey design was employed for this study.

Participants and Study Site

A total of 62 male and female stroke survivors residing within Maiduguri Metropolitan City participated in the study. Participants were recruited from two healthcare facilities: Umaru Shehu Ultra-Modern Hospital and the University of Maiduguri Teaching Hospital (UMTH). These hospitals serve as major referral centers for stroke care in Borno State and the surrounding regions.

Inclusion and Exclusion Criteria

Participants were included if they were diagnosed stroke survivors living within the metropolis, irrespective of the chronicity of their condition (acute, sub-acute, or chronic phases). Individuals with other neurological disorders, a history of fractures, or lower-limb musculoskeletal conditions that could independently affect fall risk were excluded from the study.

Sample Size Determination

The sample size was determined using the Taro-Yamane formula based on the available population of 73 stroke survivors who were registered and receiving care at the two study sites during the study period. This yielded a final sample size of 62 participants. The use of convenience sampling was employed to recruit participants voluntarily. The limited sample size is acknowledged as a limitation

of this study, and findings should be interpreted with this consideration.

Instruments

Socio-demographic and Clinical Questionnaire: A structured questionnaire was used to collect socio-demographic and clinical information, including age, gender, educational level, type of stroke, side affected, and post-stroke duration. A separate consent form was administered to document written informed consent from all participants prior to data collection.

Falls Risk Assessment Tool (FRAT): The FRAT was used to evaluate fall risk. This validated tool assesses four domains: recent falls, medication use, psychological status, and cognitive status. Higher scores indicate greater fall risk.

Stroke-Specific Quality of Life Scale (SS-QoL): The SS-QoL, a validated 49-item instrument assessing 12 health-related domains (energy, family roles, language, mobility, mood, personality, self-care, social roles, thinking, upper extremity function, vision, and work/productivity), was used to measure quality of life. Each domain is scored on a 5-point Likert scale, with higher scores indicating better QoL.

Data Collection Procedure

Data collection was conducted at the participating hospitals. Eligible participants were approached, and the study objectives were explained. Written informed consent was obtained from all participants. The socio-demographic questionnaire, FRAT, and SS-QoL were administered through face-to-face interviews conducted by trained research assistants. Clinical data were verified from participants' medical records where available.

Ethical Considerations

Ethical approval was obtained from the Borno State Ministry of Health and the University of Maiduguri Teaching Hospital

Research Ethics Committee. Written informed consent was obtained from all participants. Confidentiality was maintained throughout the study, and participants were informed of their right to withdraw at any time without consequences.

Data Analysis

Data were analyzed using SPSS version 22. Descriptive statistics (mean, standard deviation, frequencies, and percentages) were used to summarize the socio-demographic and clinical characteristics of participants. Chi-square tests were applied to determine associations between fall-risk levels, quality of life, and socio-demographic variables, as well as between quality of life and fall-risk level. Statistical significance was set at $\alpha = 0.05$.

Results

Socio-demographic Characteristics of Participants

A total of 62 stroke survivors participated in the study. Table 1 presents the socio-

demographic characteristics of the respondents. The sample comprised 32 males (51.6%) and 30 females (48.4%). The majority of respondents were within the 51–60-year age group (33.9%), followed by those aged 61–70 years (27.4%). Participants aged 31–40 years represented the smallest proportion (6.5%).

Regarding educational background, the majority had tertiary education (38.7%), while 21% had no formal education, and only 4.8% had primary-level education. In terms of post-stroke duration, 38.7% of participants were in the chronic phase (>6 months), 32.3% were in the sub-acute phase (1–6 months), and 29% were in the acute phase (<1 month). The distribution of stroke laterality indicated equal occurrence on both sides, with left and right hemiparesis each reported in 31 participants (50%).

Table 1. Socio-demographic Characteristics of Respondents

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
31–40	4	6.5
41–50	13	21.0
51–60	21	33.9
61–70	17	27.4
71–80	7	11.3
Total	62	100
Gender		
Male	32	51.6
Female	30	48.4
Total	62	100

Characteristic	Frequency (n)	Percentage (%)
Education		
None	13	21.0
Tsangaya	12	19.4
Primary	3	4.8
Secondary	10	16.1
Tertiary	24	38.7
Total	62	100
Post-stroke Duration		
Acute (<1 month)	18	29.0
Sub-acute (1-6 months)	20	32.3
Chronic (>6 months)	24	38.7
Total	62	100
Affected Body Side		
Left	31	50.0
Right	31	50.0
Total	62	100

Quality of life scores

Table 2 presents the mean scores, standard deviations, and ranges for each domain of the SS-QoL. The highest mean scores were observed in the Language domain (mean = 17.9, SD = 5.6) and Mood domain (mean = 17.4, SD = 3.3), indicating relatively better

functioning in these areas. The lowest scores were observed in the Energy domain (mean = 6.9, SD = 3.2) and Work/Productivity domain (mean = 8.6, SD = 4.4), suggesting significant impairment in these aspects of QoL.

Table 2. Quality of Life Domain Scores (SS-QoL)

Domain	Mean	SD	Min	Max
Energy (EG)	6.9	3.2	3	15
Family Roles (FR)	9.7	3.6	3	15
Language (LG)	17.9	5.6	7	25
Mobility (MB)	16.3	7.9	6	30
Mood (MD)	17.4	3.3	10	22
Personality (PS)	9.9	1.6	7	14
Self-Care (SC)	11.8	6.6	5	25
Social Roles (SR)	12.7	6.6	5	25
Thinking (TK)	10.6	3.2	3	15
Upper Extremity Function (UEF)	11.3	5.2	5	23
Vision (VS)	11.0	3.1	3	15
Work/Productivity (WP)	8.6	4.4	3	15

KEY**Max=** **Maximun****Min=** **Minimun**

Table 3. Fall Risk Domain Scores (FRAT)

Domain	Mean	SD	Min	Max
Recent Fall	2.9	1.5	1	6
Medication	2.1	0.7	1	3
Psychological	1.8	0.7	1	3
Cognitive Status	1.4	0.6	1	4
Total	8.2	2.6		

Level of fall risk

Table 3 presents the FRAT domain scores. The total mean FRAT score was 8.2 (SD = 2.6), with the highest scores observed in the recent falls domain (mean = 2.9, SD = 1.5), indicating a substantial history of falls among participants.

Association between quality of life and fall risk

Table 4 presents the Chi-square analysis examining the relationship between QoL and fall risk. The Pearson Chi-Square value ($\chi^2 = 450.352$, $df = 432$, $p = 0.262$) indicates no statistically significant association between overall QoL scores and fall-risk categories. However, the Linear-by-Linear Association value (7.058, $df = 1$, $p = 0.008$) suggests a significant linear trend when assessing the ordinal relationship between QoL and fall risk. This indicates that while the overall categorical association is not significant, a directional gradient pattern may exist across the ordered categories of QoL and fall risk.

Table 4. Association between quality of life and fall risk

Test	Value	df	p-value
Pearson Chi-Square	450.352	432	0.262

Test	Value	df	p-value
Likelihood Ratio	228.066	432	1.000
Linear-by-Linear Association	7.058	1	0.008*

*Statistically significant at $p < 0.05$

Association between socio-demographic factors and quality of life

Chi-square analysis revealed significant associations between selected socio-demographic factors and QoL domains. Age was significantly associated with upper extremity function ($p < 0.05$), consistent with age-related decline in motor performance. Gender showed significant associations with mobility and self-care domains. Educational level was significantly associated with multiple QoL domains, including language, social roles, and thinking. Post-stroke duration showed significant associations with energy, mobility, and work/productivity domains ($p < 0.05$).

Association between socio-demographic factors and fall risk

No socio-demographic variable showed a statistically significant association with fall risk ($p > 0.05$ for all variables). Age, gender, educational level, and post-stroke duration did not significantly influence fall risk status among participants.

Discussion

This study assessed quality of life and fall risk among stroke survivors in selected hospitals in Maiduguri, Borno State. The findings provide valuable insights into the functional and psychosocial outcomes of stroke survivors in a conflict-affected region of Northern Nigeria.

The gender distribution observed in this study (male and female) differed from the more pronounced male predominance reported in some previous Nigerian studies [17], although stroke remains more common among males globally [18]. The age distribution revealed that the majority of participants were aged 51-70 years, consistent with findings that stroke predominantly affects the older adult population [19]. The high proportion of participants with tertiary education (38.7%) reflects the urban nature of the study setting in Maiduguri Metropolitan City, while the 21% with no formal education highlights the continued need for health literacy interventions in the region.

The study found that specific socio-demographic factors significantly influenced QoL domains. Educational level was significantly associated with language, social roles, and thinking domains, supporting the assertion that higher education enhances coping strategies and self-management capabilities [20]. This finding aligns with recent literature demonstrating that health literacy, which is closely linked to educational attainment, facilitates better engagement with rehabilitation and adaptation to post-stroke challenges [21]. Our findings suggest that stroke survivors with higher educational attainment may be better equipped to navigate the rehabilitation

process and access available support resources.

Age was significantly associated with upper extremity function, consistent with the established age-related decline in motor performance and neuromuscular efficiency [22]. This finding is supported by recent research from the University of Maiduguri Teaching Hospital, which documented that stroke survivors aged 56.0 ± 15.8 years show varying functional outcomes based on age-related factors [10]. Additionally, a study of 85 hospitalized stroke patients found that age was significantly associated with functional independence and discharge outcomes ($p < 0.05$) [23].

Post-stroke duration showed significant associations with energy, mobility, and work/productivity domains. This finding is consistent with previous research indicating that QoL varies across different phases of stroke recovery [24]. Participants in the chronic phase (38.7%) may have developed better adaptation strategies and compensation mechanisms compared to those in the acute phase. However, the persistence of QoL impairment in the chronic phase highlights the need for continued rehabilitation support beyond the acute period. A Nigerian study similarly found that health-related QoL scores were lowest in the early sub-acute phase but demonstrated improvement over time in some domains [25].

Gender was significantly associated with mobility and self-care domains. This finding supports previous research suggesting differential recovery trajectories between male and female stroke survivors [26]. Females may face additional challenges related to caregiving responsibilities and socio-cultural expectations in the Nigerian context, potentially influencing their rehabilitation participation and outcomes [27].

The mean FRAT score of 8.2 (SD = 2.6) in this study indicates moderate fall risk among participants. The highest scores were observed in the recent falls domain (mean = 2.9), suggesting a substantial history of falls in this population. This finding is consistent with the international evidence that over 30% of stroke survivors experience falls within the first year post-stroke [12]. The absence of significant associations between fall risk and socio-demographic factors aligns with some studies [28] but contrasts with others that have reported age and gender differences in fall risk [29]. This disparity may be attributable to sample size constraints, variability in stroke severity, or differences in the measurement tools used.

Interestingly, no statistically significant association was found between overall QoL and fall risk ($p = 0.262$). This finding contrasts with studies that have demonstrated significant associations between impaired balance and reduced QoL [30]. However, the significant Linear-by-Linear Association ($p = 0.008$) suggests a gradient pattern, indicating that as QoL improves, fall risk tends to decrease in an ordered fashion. This nuanced relationship may reflect the complex, multifactorial nature of both constructs. Recent research has shown that falls are significantly associated with reduced life satisfaction among hospitalized stroke patients (OR = 0.77, 95% CI: 0.61-0.98, $p = 0.0325$) [16], suggesting that the relationship may be more apparent when specific aspects of QoL are examined rather than global scores.

Furthermore, a study among chronic stroke patients found that social roles and upper extremity function were significantly associated with fall experiences, with the fall group demonstrating significantly lower scores in self-help activities, social roles, and upper extremity function ($p < 0.05$) [14].

These findings highlight that the relationship between QoL and fall risk may be domain-specific, with certain aspects of QoL (such as physical function and social participation) being more closely linked to fall risk than others.

The absence of a strong overall association in our study may also be explained by cultural factors. In the Nigerian context, QoL may be influenced by factors such as family support, religious beliefs, and community integration that are not captured by the SS-QoL tool. Additionally, the relatively high prevalence of falls (46.5% occurring within 2-6 months post-stroke) [13] may have normalized fall experiences among participants, potentially attenuating the perceived impact on QoL. The consequences of falls, including fractures and ligament strains occurring in over 54% of cases [13], underscore the need for comprehensive fall prevention strategies regardless of QoL scores.

Clinical Implications

The findings of this study have several clinical implications. The significant associations between socio-demographic factors and QoL highlight the need for tailored rehabilitation approaches that consider individual patient characteristics. Educational level, in particular, may serve as a marker for health literacy and should be considered when designing patient education and self-management interventions [21]. The influence of post-stroke duration on QoL domains underscores the importance of ongoing rehabilitation throughout the recovery trajectory, with particular attention to the acute and sub-acute phases when QoL may be most compromised.

The moderate fall risk scores and high recent falls scores emphasize the critical need for systematic fall risk assessment in stroke rehabilitation. Fall prevention interventions,

including balance training, environmental modifications, and education on fall prevention strategies, should be integrated into standard stroke care. Despite the lack of significant association between socio-demographic factors and fall risk in this study, clinical vigilance for fall risk remains essential for all stroke survivors.

Study Limitations

This study has several limitations that should be acknowledged. First, the sample size ($n = 62$) is relatively small, which limits the generalizability of findings to the broader stroke survivor population in Maiduguri. The convenience sampling method may also introduce selection bias. Second, the cross-sectional design precludes establishing causal relationships between QoL and fall risk. Third, the study was conducted in two hospitals, which may not be representative of all stroke survivors, particularly those who do not seek hospital-based care. Fourth, the use of self-report measures may be subject to recall bias and social desirability bias. Fifth, the conflict context of Maiduguri may have influenced the experiences and outcomes of participants in ways that are not fully captured by the quantitative measures used. Future studies should employ larger, community-based samples and incorporate qualitative methods to better understand the experiences of stroke survivors in conflict-affected regions.

Conclusion

This study found no statistically significant association between overall quality of life and fall risk among stroke survivors in selected hospitals in Maiduguri, Borno State. However, a significant linear trend suggested a directional relationship between these variables. Fall risk was not significantly associated with socio-demographic characteristics of the participants. In contrast,

quality of life was significantly associated with specific socio-demographic factors including age, gender, educational level, and post-stroke duration. These results indicate that while socio-demographic characteristics influence functional and psychosocial outcomes among stroke survivors, fall risk may be determined by other clinical or functional factors beyond basic demographic profiles.

Recommendations

Based on the findings of this study, the following recommendations are made:

- **Comprehensive QoL Assessment:** Physiotherapists and rehabilitation professionals should consistently assess the quality of life of stroke survivors as part of their management plan to ensure comprehensive and holistic care delivery.
- **Fall Risk Evaluation and Prevention:** Physiotherapists should systematically evaluate the risk of falls among stroke survivors and implement balance training and other appropriate interventions for those identified at risk to enhance stability and prevent potential falls.
- **Tailored Rehabilitation:** Rehabilitation interventions should consider socio-demographic factors, particularly educational level and post-stroke duration, in designing patient education, self-management strategies, and treatment protocols.
- **Future Research:** Researchers are encouraged to conduct further studies with larger sample sizes, community-based designs, and longitudinal follow-up to address existing knowledge gaps and validate these findings. Qualitative studies should also be conducted to explore the lived

experiences of stroke survivors in conflict-affected regions.

- **Public Health Education:** Public health education programs on stroke risk factors, warning signs, and the importance of rehabilitation services should be prioritized in conflict-affected regions like Maiduguri to improve awareness and health-seeking behaviors.
- **Health System Strengthening:** Healthcare administrators and policymakers should strengthen rehabilitation services and fall prevention programs in hospitals serving stroke survivors, particularly in resource-limited settings.

Limitations

This study is limited by a relatively small sample size ($n = 62$), which constrains the statistical power and generalizability of the findings. The use of convenience sampling from two hospitals may not be representative of all stroke survivors in Maiduguri, particularly those who do not access hospital-based care. The cross-sectional design limits causal inferences. Additionally, self-report measures may be subject to recall and social desirability biases. The conflict context of Maiduguri may have influenced outcomes in ways not fully captured by the quantitative methods employed. Future studies with larger, community-based samples are needed to validate these findings.

Conflict of Interest

The authors declare no conflict of interest.

Funding

No external funding was received for this study.

References

1. Feigin VL, Stark BA, Johnson CO, Roth GA, Bisignano C, Abady GG, et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a

- systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol.* 2021;20(10):795-820.
2. Thayabaranathan T, Kim J, Cadilhac DA, Thrift AG, Donnan GA, Howard G, et al. Global stroke statistics 2022. *Int J Stroke.* 2022;17(9):946-956.
 3. Owolabi MO, Akarolo-Anthony S, Akinyemi R, Arnett D, Gebregziabher M, Jenkins C, et al. The burden of stroke in Africa: a glance at the present and a glimpse into the future. *Cardiovasc J Afr.* 2015;26(2 Suppl 1):S27-S38.
 4. Ugoh CE, Eze EB, Ejekam CS. Stroke prevalence dynamics in south-east Nigeria: predictions using dynamic regression modeling. *J Stroke Cerebrovasc Dis.* 2022;31(8):106573.
 5. Saunders DH, Sanderson M, Hayes S, Johnson L, Kramer S, Carter DD, et al. Physical fitness training for stroke patients. *Cochrane Database Syst Rev.* 2020;3(3):CD003316.
 6. Li Y, Li Y, Chen C, Zhang Y, Chen X. The prevalence and risk factors of falls among stroke patients: a systematic review and meta-analysis. *J Clin Nurs.* 2022;31(11-12):1500-1512.
 7. Bello UM, Chutiyami M, Salihu D, Abdu SU, Tafida BA, Jabbo AA, et al. Quality of life of stroke survivors in Africa: a systematic review and meta-analysis. *Qual Life Res.* 2021;30(1):1-9.
 8. Ojagbemi A, Akinwande O, Akinyemi R, Owolabi M. Resilience and quality of life in Nigerian stroke survivors: a longitudinal study. *Int J Stroke.* 2025;20(2):180-189.
 9. Ameen AI, Lawal OJ, Alabi OO. Assessment of stroke severity and health-related quality of life among Nigerian stroke survivors. *J Stroke Cerebrovasc Dis.* 2023;32(4):107045.
 10. Usman JS, Owwoeye OBA, Adegoke BOA. Functional outcomes and quality of life among stroke survivors in University of Maiduguri Teaching Hospital: a retrospective study. *Niger J Health Sci.* 2024;24(1):10-18.
 11. World Health Organization. Falls fact sheet. Geneva: WHO; 2023.
 12. Weerdesteyn V, de Niet M, van Duijnhoven HJ, Geurts AC. Falls in individuals with stroke. *J Rehabil Res Dev.* 2020;57(1):1-12.
 13. Park HJ, Lee JH, Kim JS, Kim YH, Shin JH. Characteristics and consequences of falls in hospitalized patients with stroke. *J Korean Soc Phys Med.* 2025;20(1):45-55.
 14. Kim JH, Park HJ, Lee JH, Kim JS, Shin JH. Association between falls and quality of life in chronic stroke patients: a cross-sectional study. *J Phys Ther Sci.* 2024;36(3):145-152.
 15. Vincent-Onabajo G, Musa HY, Joseph E. Prevalence of balance impairment among stroke survivors undergoing neurorehabilitation in Nigeria. *J Stroke Cerebrovasc Dis.* 2018;27(12):3487-3492.
 16. Lee JS, Park HJ, Kim JH, Shin JH. Association between falls and life satisfaction among hospitalized stroke patients: a prospective cohort study. *J Clin Med.* 2024;13(6):1587.

17. Gbiri CA, Akinpelu AO. Quality of life of Nigerian stroke survivors during first 12 months post-stroke. *Hong Kong Physiother J*. 2012;30(1):18-24.
18. Appelros P, Nydevik I, Viitanen M. Poor outcome after first-ever stroke: predictors for death, dependency, and recurrent stroke within the first year. *Stroke*. 2003;34(1):122-126.
19. Di Carlo A. Human and economic burden of stroke. *Age Ageing*. 2009;38(1):4-5.
20. Oyewole OO, Oritogun KS, Gbiri CA. Functional recovery and its predictors after sub-acute stroke rehabilitation in a Nigerian tertiary health facility: a preliminary finding. *Rehabil J*. 2023;18(2):100-112.
21. AlHassan SA, AlAteeq MM, AlAteeq SM. Health literacy and its association with quality of life among stroke survivors: a systematic review. *Patient Educ Couns*. 2023;112:107733.
22. Seidler RD, Bernard JA, Burutolu TB, Fling BW, Gordon MT, Gwin JT, et al. Motor control and aging: links to age-related brain structural, functional, and biochemical effects. *Neurosci Biobehav Rev*. 2010;34(5):721-733.
23. Adeyemi OT, Oyewole OO, Onwuakagba IU. Age-related factors influencing functional outcomes among stroke survivors in a Nigerian tertiary hospital. *J Stroke Cerebrovasc Dis*. 2024;33(5):107682.
24. Kwakkel G, Kollen BJ, Wagenaar RC. Long term effects of intensity of upper and lower limb training after stroke: a randomised trial. *J Neurol Neurosurg Psychiatry*. 2002;72(4):473-479.
25. Akinpelu AO, Olaogun MO, Adegoke BOA. Health-related quality of life of Nigerian stroke survivors. *Afr J Health Sci*. 2023;34(3):456-465.
26. Reeves MJ, Bushnell CD, Howard G, Gargano JW, Duncan PW, Lynch G, et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. *Lancet Neurol*. 2008;7(10):915-926.
27. Vincent-Onabajo G, Ali A, Hamzat T. Quality of life of Nigerian informal caregivers of community-dwelling stroke survivors. *Scand J Caring Sci*. 2013;27(4):977-982.
28. Jørgensen L, Engstad T, Jacobsen BK. Higher incidence of falls in long-term stroke survivors than in population controls: depressive symptoms and fall-related risk factors. *Int J Rehabil Res*. 2024;47(2):95-102.
29. Chan PPW, Siu JHM, Cheung CHY. Falls and fall prevention in community-dwelling stroke survivors: a systematic review. *J Stroke Cerebrovasc Dis*. 2023;32(8):107187.
30. Winser SJ, Chan HK, Chen WK, Hau CY, Leung SH, Leung YH, et al. Effects of therapeutic exercise on disease severity, balance, and functional independence among individuals with cerebellar ataxia: a systematic review with meta-

analysis. *Physiother Theory Pract.*
2023;39(7):1355-1375.

Association between ophthalmic artery Doppler indices and adverse perinatal outcomes in women with pre-eclampsia in Kano, Nigeria

Hussaini Dede¹, Anas Ismail², Yusuf Lawal², Ayyuba Rabi³, Isa Hassan Muhammad¹

¹Department of Radiology, Yobe State University, Damaturu, Nigeria

²Department of Radiology, Bayero University, Kano, Nigeria

³Department of Obstetrics and Gynaecology, Bayero University, Kano, Nigeria

Corresponding Author: Dr Hussaini Dede Email: dedehussaini@yahoo.com

<https://dx.doi.org/10.4314/yomj.v2i2.4>

Received: 03-Jun-2026

Accepted: 22-Aug-2026

Published: 31-Aug-2026

Abstract

Background: - Pre-eclampsia (PE) as a pregnancy-related hypertensive disorder poses a significant challenge to maternal and foetal health in low and middle-income countries, like Nigeria. The ophthalmic artery Doppler (OAD) is a tool that has been studied to aid in diagnosing PE, since its pathogenesis is not limited to the placental bed, but extends to cardiovascular and endothelial adaptations during pregnancy. Abnormal maternal ophthalmic artery Doppler velocimetry is associated with poor perinatal outcomes. **Objectives:** - To determine ophthalmic artery Doppler velocimetric indices of patients with pre-eclampsia using ultrasonography and correlate these indices with pregnancy-related outcomes. **Materials and methods:** - This was an observational cohort study carried out at a tertiary hospital in Nigeria. Eighty-two pre-eclamptic patients and an equal number of normotensive-matched pregnant controls were recruited for the study. The ophthalmic artery peak ratio, pulsatility index, and resistive index of both groups were obtained using high-resolution ultrasound Doppler examination. These parameters were then correlated with selected maternal and perinatal outcomes. **Results:** The mean age of pre-eclamptic subjects ($28\text{years} \pm 3.86$) and that of the control subjects ($27.52\text{years} \pm 4.36$) were not statistically different ($p = 0.444$). Gestational ages were also similar between the two groups (pre-eclamptic: mean = $33.24\text{weeks} \pm 2.89$; normotensive: mean $33.41\text{weeks} \pm 3.72$; $p = 0.74$).

The ophthalmic artery RI, PI and PR were significantly associated with adverse perinatal outcomes. These outcomes include: low birthweight ($p = 0.01$) stillbirth ($P < 0.003$) and depressed Apgar score ($p = 0.001$). **Conclusions:** This study found significant association between ophthalmic artery velocimetric indices and adverse perinatal outcomes, suggesting that ophthalmic artery Doppler can enhance risk stratification and improve perinatal outcomes.

Key Words: - Ophthalmic artery, pre-eclampsia, Doppler, velocimetry, perinatal outcomes

Cite this article: Dede H, Ismail A, Lawal Y, Rabi A, Muhammad IH. Association between ophthalmic artery Doppler indices and adverse perinatal outcomes in women with pre-eclampsia in Kano, Nigeria. Yob Med J.2026;2(2):116-124

Introduction

Pre-eclampsia (PE) is a pregnancy-related hypertensive disorder occurring usually after 20 weeks of gestation.¹ If left untreated, it progresses to eclampsia.² As estimated by World Health Organization (WHO), the occurrence of PE is seven times higher in developing countries compared to developed countries.³ In Nigeria the prevalence of PE ranges between 2% and 16.7%.⁴ The incidence of eclampsia lies in the range of 0.3 per 1000 deliveries in Calabar (Southern Nigeria) to as high as 9 per 100 deliveries in Birnin Kudu, (Northwestern Nigeria).⁵

Hypertensive disorders are a common complications of pregnancy that put women and their foetuses at disproportionate risk for further complications, as well as life-long sequelae.⁶ Classically, the American College of Obstetrics and Gynaecology (ACOG) defines pre-eclampsia as the presence of hypertension and proteinuria occurring after 20 weeks of gestation in a previously normotensive patient.⁷ However, a significant proportion of women develop systemic manifestations of PE such as low platelets or elevated liver enzymes before the hallmark of proteinuria is detectable resulting in delayed diagnoses.⁶ The common maternal adverse perinatal outcome of PE include: maternal mortality, eclampsia, premature rupture of membrane, presence of antepartum haemorrhage or postpartum haemorrhage (blood loss at birth 500 mL or greater), and admission to the intensive care unit. Foetal adverse outcome include: depressed Apgar score, low birth weight, stillbirth and admission to the neonatal unit.⁸

PE is characterized as mild or severe based on the degree of hypertension, proteinuria and the presence of symptoms resulting from involvement of systemic organs.⁹ Severe PE is a serious clinical type of PE manifested by at least one of the followings: persistent increase in blood pressure ($\geq 160/110$ mmHg), hepatic or renal failure, haemolytic anaemia, elevated liver enzymes and low

platelet count (HELLP syndrome), cerebral or visual disturbances, persistent severe epigastric pain and pulmonary edema.¹⁰ If left untreated, the disorder often leads to serious maternal and perinatal complications.¹¹

Uterine artery and several peripheral vessels Doppler indices have been investigated as a potential marker for the development of pre-eclampsia, among which is ophthalmic artery Doppler (OAD). Evaluating ophthalmic artery with Doppler sonography is easy using standard ultrasound equipment and is unaffected by adiposity. Furthermore, the Doppler velocimetric indices have constant reference ranges throughout trimesters of pregnancy.¹² There is paucity of data regarding the relationships between ophthalmic artery Doppler velocimetric indices and adverse perinatal outcomes in patients with pre-eclampsia.

Although ophthalmic artery Doppler (OAD) ultrasound offers a promising, cost-effective approach to evaluate pre-eclampsia and predict perinatal outcomes¹³, there is paucity of studies on its effectiveness in predicting perinatal outcome of PE in Nigeria.

This study is aimed at evaluating the parameters of the ophthalmic artery Doppler velocimetry in patients with PE and correlate them with perinatal outcome (for both mother and foetus/new-born).

Materials and methods

This hospital based prospective cohort study was carried out in Aminu Kano Teaching Hospital (AKTH). It is a tertiary care facility in Kano, Nigeria. Using a systematic random sampling technique, 82 pregnant women being managed for pre-eclampsia at the obstetrics and gynaecology department of AKTH, and an equal number of matched normotensive pregnant women as controls were recruited into the study. The two groups were matched in terms of maternal age and gestational age.

The study was conducted within 8 months (December, 2023 – July, 2024) after

obtaining institutional ethics board approval from the Aminu Kano Teaching Hospital Health Research Ethics Committee. The first 3 months of the study were used for recruiting the study subjects, obtain ophthalmic artery Doppler velocimetry and other antenatal data as well as perinatal outcome data (for those that deliver within the first 3 months of the study). The last 5 months of the study were used to obtain data on perinatal outcomes. Pregnant women who were not-consenting, smokers, having multiple pregnancies, orbital pathologies and maternal conditions before pregnancy, such as diabetes mellitus, chronic hypertension, and HIV infection, were excluded from both study groups. Informed consents were obtained from the study and control groups. Data were obtained using structured data collection sheet. The maternal age, blood pressure (BP), gestational age and estimated foetal weight (by ultrasound scan) of study group were obtained. Similar information were obtained from the control group. The ophthalmic artery peak ratio (PR), pulsatility index (PI), and resistive index (RI) were obtained for both study and control groups. Both groups were then followed up to the time of delivery and the following perinatal outcomes were recorded: foetal Apgar score, birth weight and stillbirth.

Technique for ophthalmic artery Doppler scan

Ultrasound scanning was performed using HYVission V5 Panascope digital ultrasound machine, equipped with 6.8-15MHz transducer. An acoustic coupling gel was applied on the transducer which was then placed directly and gently on the closed eyelid with the gaze directed at the ceiling.¹⁴ The examiner's hand was rested on the orbital margin to minimize the applied pressure to the globe and the orbit. The insonation angle was kept below 20° with high-pass filter set to its minimum value.⁴ Real time grey scale and colour Doppler scanning was then performed in longitudinal

and transverse planes of both globes. The hypoechoic stripe of the optic nerve was then identified with the ophthalmic artery just medial to it.¹⁵ Using colour Doppler, the ophthalmic artery was further identified by its colour flow and pulsatility at about 15 millimetres from the optic disc (on the medial aspect of the optic nerve). Pulsed-wave Doppler was then applied, with sample volume placed around 15mm behind optic disc, medial to optic nerve; sample volume was about 2mm in length.⁴

The Doppler sample gate (≤ 2 mm) was placed at the centre of the detected vessel to image the spectral pattern. Pulse repetition frequency (PRF) was set at 125 kHz and adjusted as appropriate.¹⁴

The velocimetric indices which include, Resistive index (RI), Pulsatility Index (PI) and peak ratio (PR) were obtained from the ultrasound machine which has the manufacturer calibrated automatic calculator for RI and PI. While the PR was calculated manually by dividing the second peak systolic velocity (P2) with the peak systolic velocity (PSV). Both ophthalmic arteries were insonated and measurement taken three times on both right and left side, and average of each of the three reading were recorded.

Data generated were analysed using IBM statistical product and service solutions (SPSS) statistics software version 22.0 New York, USA. Mean $\pm$ standard deviation was used to summarize quantitative variables. T-test was used to compare continuous with group/categorical variables with two levels. Findings were then presented numerically, graphically and in tabular forms. A p-value of 0.05 or below was considered to be statistically significant.

Ethical consideration

Prior to commencement of the study, ethical approval was obtained from the ethics committee of Aminu Kano Teaching Hospital Kano. Furthermore, an informed consent was obtained from all the members of the study and control groups. Doppler

ultrasonography of the eye is a non-ionizing based imaging modality and considered relatively safer compared to other imaging modalities.⁴² Patient confidentiality was protected by removing identification markers on all images obtained during the study. During the study, the researcher was responsible for any financial burden of the investigation and participants did not pay for any investigation outside the standard of care. Imaging cost were covered by the researcher. Participants with incidental abnormalities detected in the course of the ophthalmic artery Doppler ultrasound scan or the obstetrics scan were referred to the appropriate specialist for further evaluation.

Results

This study was conducted over a period of 8 months from December 2023 to July 2024. A total of 164 subjects were recruited into the study, comprising 82 pre-eclamptic subjects and equal number of normotensive pregnant controls. However, 2 pre-eclamptic subjects were lost to follow-up. As a result, a total of 160 subjects comprising 80 pre-eclamptic and equal number of normotensive control subjects were reviewed for analysis in this study.

Socio-Demographics of the Study Subjects

The age range of pre-eclamptic subjects was 19 – 38 years with a mean age of 28 ± 3.86 years while that of the normotensive pregnant control subjects was 18 – 37 years with a mean of 27.52 ± 4.36 years. The mean age difference between the two groups was not statistically significant ($p = 0.444$). The highest number of the respondents were found in the age range of 25 – 29 years comprising of 37 individuals (46.3%) in both the pre-eclamptic subjects and normotensive pregnant control groups as shown in **Table 1**. The gestational age of the pre-eclamptic group ranges from 28 – 38 weeks with a mean gestational age of 33.24 ± 2.89 weeks, while that of the normotensive pregnant control subjects was 25 – 40 weeks with a mean of 33.41 ± 3.72 weeks. There is no statistically

significant difference between the mean gestational ages of the two groups ($P = 0.74$) as shown in the **Table 1** below.

Table 1: Socio-demographic Characteristics of pre-eclamptic and normotensive pregnant control Subjects:

Variables	Pre-eclamptic subjects n=80 (%)	Normotensive pregnant control n=80 (%)	Total n=160	P-value
Age (Years)				
<20	2 (2.5)	2 (2.5)	4	
20-24	12 (15.0)	12 (15.0)	24	
25-29	37 (46.3)	37 (46.3)	74	
30-34	23 (28.8)	23 (28.8)	46	
35-40	6 (7.5)	6 (7.5)	12	
Mean $\pm$ SD	28 ± 3.82	27.54 ± 4.32		P = 0.444
Gestational age (weeks)				
20 - 24	0	0	0	
25 - 29	9 (11.3)	9 (11.3)	18	
30 - 34	37 (46.3)	37 (46.3)	74	
35 - 40	34 (42.5)	34 (42.5)	68	
Mean $\pm$ SD	33.19 ± 2.88	33.42 ± 3.68		P = 0.740

Correlation between RI, PI and PR with apgar score among pre-eclamptic subjects.

There was statistically significant negative correlation between APGAR score and PR ($P = 0.00008$). On the other hand, statistically significant positive correlation was observed between APGAR score and RI ($P = 0.000017$) and PI ($P = 0.001$)-**Tables 2**

Table 2: Correlation of ophthalmic artery Doppler velocimetric indices (RI, PI and PR) with APGAR score among pre-eclamptic subjects.

APGAR Score		
Pearson correlation	Sig. (2-tailed)	N

Right Side	RI	0.458	0.001*	80
	PI	0.374	0.001*	80
	PR	-0.568	0.001*	80
Left Side	RI	0.472	0.001*	80
	PI	0.368	0.001*	80
	PR	-0.532	0.001*	80

*Correlation is significant at the $P < 0.05$ level (2-tailed).

Relationship between RI, PI and PR with birthweight among the babies of preeclamptic subjects.

The mean RI, PI and PR values for pre-eclamptic subjects delivered of babies with normal birthweight were 0.62, 1.02 and 0.72 respectively on the right side. The corresponding values on the left were 0.62, 1.04 and 0.71 respectively. The mean RI, PI and PR values for pre-eclamptic subjects delivered of babies with low birth weight were 0.56, 0.83 and 0.76 respectively on the right side. The corresponding values on the left side were 0.56, 0.82 and 0.77 respectively.

The pre-eclamptic subjects that delivered of babies with low birthweight had higher PR with lower IR and PI compared with mothers who delivered babies having normal birthweight ($P < 0.003$) as shown in Table 3.

Table 3: Relationships between ophthalmic arteries RI, PI and PR with birthweight among pre-eclamptic subjects.

BIRTHWEIGHT				
		Normal birthweight n = 56	Low birthweight n = 24	P-VALUE
Right Side	RI	0.62	0.56	0.006*
	PI	1.04	0.83	0.003*
	PR	0.71	0.76	0.003*
Left Side	RI	0.62	0.56	0.006*
	PI	1.04	0.83	0.003*
	PR	0.71	0.76	0.003*

RI	0.62	0.56	0.005*
PI	1.02	0.82	0.003*
PR	0.72	0.77	0.010*

*Statistically significant at $p \leq 0.05$

Relationship between RI, PI and PR and rate of stillbirth among the pre-eclamptic subjects.

The mean RI, PI and PR values for pre-eclamptic subjects that had stillbirth were 0.59, 0.93 and 0.74 respectively on the right side. The corresponding values on the left were 0.59, 0.92 and 0.74 respectively. The mean RI, PI and PR values for pre-eclamptic subjects that had live-birth were 0.49, 0.65 and 0.84 respectively on the right side. The corresponding values on the left side were 0.49, 0.65 and 0.84 respectively.

The pre-eclamptic subjects who had stillbirth had statistically significant lower IR and PI with higher PR compared to the pre-eclamptic subjects that had live-birth (all P values < 0.003). Table 4.

Table 4: Relationships between ophthalmic arteries RI, PI and PR with the rate of stillbirth among pre-eclamptic subjects.

		Live birth, n = 11	Stillbirth, n = 69	P-VALUE
Right Side	RI	0.59	0.49	0.001*
	PI	0.93	0.65	0.003*
	PR	0.74	0.84	0.001*
Left Side	RI	0.59	0.49	0.001*
	PI	0.92	0.65	0.003*
	PR	0.74	0.84	0.001*

*Statistically significant at $p \leq 0.05$

Discussion

A total of 80 pre-eclamptic subjects were evaluated in this study with an equal number of normotensive pregnant control groups summing up to 160 participants. The mean

age of the pre-eclamptic subjects is 28 ± 3.86 years with an age range of 19 – 38 years. Similarly, the control group has a mean age and range of 27.52 ± 4.36 years and 18 – 37 years respectively. The modal age for both the study and control groups is 25 – 29 years. The difference between the mean age of the study and control groups was not statistically significant (P- value = 0.444), because they were matched. The mean age obtained in this study (27.52 ± 4.36 years) was similar one Nigerian study, by *Mustapha et al*¹⁶ in Northwestern Nigeria (at 27.24 ± 4.16) and another Asian study by *Rani et al*¹⁷ in India (at 26.58 ± 4.30). However, *Olatunji et al*⁴ in Southwestern Nigeria and *Sapantzoglou et al* in United Kingdom obtained higher mean age values in their studies at 32.4 ± 4.7 years and 34.95 ± 4.95 years. These differences were likely due to socio-cultural variation in terms of the time of marriage and childbearing among the regions. The modal age of this study was also in agreement with what was reported by *Melese et al*¹⁰ in Ethiopia.

The mean gestational age of the pre-eclamptic group was 33.24 ± 2.89 , while that of the control group was 33.41 ± 3.72 weeks. The modal gestational age for the two groups was 25 – 29 weeks. While the literature confirmed that there are no changes in ophthalmic artery Doppler indices as gestation advances,^{12,13} there was no statistically significant difference between the mean gestational age of pre-eclamptic subjects and their control groups (P value = 0.74). The modal gestational age presented in this study was similar to what was found by *Olatunji et al*⁴ in Southwestern Nigeria where a gestational age of less than 30 weeks was reported. The mean gestational age of the pre-eclamptic group was also similar to what was recorded by *Mustapha et al*¹⁶ in Northwestern Nigeria at 33.20 ± 3.74 weeks.

This study found statistically significant negative correlation between the APGAR score of babies of pre-eclamptic subjects and maternal ophthalmic artery P2 (P = 0.03),

EDV (P = 0.028) and PR (P = 0.00008), with statistically significant positive correlation observed between the APGAR score and RI (P < 0.001) and PI (P = 0.001). There is paucity of data, correlating maternal ophthalmic artery Doppler velocimetric indices with the new-born APGAR score.

This study also demonstrated that pre-eclamptic subjects that were delivered of babies having low birthweight had higher PSV (P = 0.009), EDV (P = 0.001), P2 (P = 0.002) and PR (P = 0.003) with lower RI (P = 0.006) and PI (P = 0.003) compared with pre-eclamptic mothers that were delivered of babies having normal birthweight. Similar findings are reported from a Brazilian study by *Maria et al*,¹⁸ where pre-eclamptic mothers with higher PR had the smallest babies. Similarly *Gyokova et al*¹⁹ in Bulgaria and *Manchu et al*²⁰ in India reported statistically significant negative correlation between PR and birth weight in patients with preeclampsia.

The pre-eclamptic subjects who had stillbirth (in this study) had statistically significant lower RI (P < 0.001) and PI (P = 0.003) with a higher PR (P < 0.001) compared to the pre-eclamptic subjects that had livebirth. The PSV, EDV and P2 had no statistically significant difference between the two groups (P = 0.99, 0.164 and 0.299). There is paucity of data interrogating direct relationships between the rate of stillbirth and ophthalmic artery Doppler velocimetric indices among preeclamptic subjects. However, *Maria et al*,¹⁸ in Brazil and *Gyokova et al*²¹ in Bulgaria reported relationships between higher ophthalmic artery peak ratio (PR) and adverse perinatal outcomes.

One of the strengths of this study was being a prospective study. The findings underscore the potential of ophthalmic artery Doppler velocimetry as a valuable tool in predicting adverse perinatal outcomes in patients with pre-eclampsia.

The limitation of this study include the fact that it was conducted at a single centre, highlighting the potential for selection bias due to its limited geographic scope. While the findings regarding ophthalmic artery Doppler parameters are significant, the results may not fully represent the broader population. Secondly, long term perinatal complications were not addressed in this study due to time and resource limitation.

Conclusions

From findings in this study, it was observed that ocular vascular resistance among pre-eclamptic subjects determined by Doppler velocimetric indices was significantly lower than in the normotensive pregnant control group. There was a statistically significant relation between ophthalmic artery Doppler velocimetric indices and adverse perinatal outcomes. The ophthalmic artery Doppler velocimetry has the potential to improve risk stratification, and overall perinatal outcomes.

References

1. Jimmy E, Alex V, Christian MP SH. American College of Obstetricians and Gynecologists, The2020.Gestational Hypertension and Pre-eclampsia: ACOG Practice Bulletin Summary, Number 222. *Obstet Gynecol.* 2020;135(6):1492-1495.
2. Osungbade KO, Ige OK. Public health perspectives of pre-eclampsia in developing countries: implication for health system strengthening. *J Pregnancy.* 2011;2011:481095. doi:10.1155/2011/481095
3. Ananya DM, Zitu B, Mahmudul H, Rakib M, Jaasia MH, Aporajita DT NA. Prevalence of pre-eclampsia and the associated risk factors among pregnant women in Bangladesh. *Sci Rep.* 2021;11(1):1-9. doi:10.1038/s41598-021-00839-w
4. Olatunji RB, Adekanmi AJ, Obajimi MO, Roberts OA, Ojo TO. Maternal ophthalmic artery Doppler velocimetry in pre-eclampsia in Southwestern Nigeria. *Int J Womens Health.* 2015;7:723-734. doi:10.2147/IJWH.S86314
5. Kooffreh M, Ekott M, Ekpoudom D. The prevalence of pre-eclampsia among pregnant women in the University of Calabar Teaching Hospital, Calabar. *Saudi J Heal Sci.* 2014;3(3):133. doi:10.4103/2278-0521.142317
6. Donald KH, Wanda DB, Nicole DF, Shanna C, Jean YK, Lijing O, Lisa R, Tiffany C CD. Hypertensive Disorders in Pregnancy and Mortality at Delivery Hospitalization — United States, 2017–2019. *MMWR Morb Mortal Wkly Rep.* 2022;71(17):585-591. doi:10.15585/mmwr.mm7117a1
7. Tessema GA, Tekeste A, Ayele TA. Pre-eclampsia and associated factors among pregnant women attending antenatal care in Dessie referral hospital, Northeast Ethiopia: A hospital-based study. *BMC Pregnancy Childbirth.* 2015;15(1):1-7. doi:10.1186/s12884-015-0502-7
8. Kehinde SO, Christian CM, Ugwu AO, Emmanuel O, Ayodeji AO, Adaiah PS, Garba SR, Rasheed AO, Salimat AY, Sunday IO, Nneoma KA, Lulu GO, Ifunanya TO EA. Maternal and perinatal outcomes of pre-eclampsia at a tertiary hospital in lagos, Nigeria. *Int J Med Heal Dev.* 2022;27(2):197. doi:10.4103/ijmh.ijmh_46_21
9. The royal women's hospital. Pre-Eclampsia: Management. Australia. Published 2020. https://thewomens.r.worldssl.net/images/uploads/downloadable-records/clinical-guidelines/pre-eclampsia-management_280720.pdf
10. Melese MF, Badi MB, Aynalem GL. Perinatal outcomes of severe pre-eclampsia/eclampsia and associated

- factors among mothers admitted in Amhara Region referral hospitals, North West Ethiopia, 2018. *BMC Res Notes*. 2019;12(1):1-6. doi:10.1186/s13104-019-4161-z
11. Lin L, Huai J, Su R, Wang C, Li B, Yang H. Incidence and clinical risk factors for pre-eclampsia and its subtypes: A population-based study in beijing, china. *Matern Med*. 2021;3(2):91-99. doi:10.1097/FM9.0000000000000099
 12. Pollyanna M, Leonardo R. Tânia MS, Fabrício SC, Daniel LR AL. Ophthalmic artery Doppler in the complementary diagnosis of pre-eclampsia: a systematic review and meta-analysis. Published online 2022;111.https://doi.org/10.21203/rs.3.rs-1765757/v1
 13. Kalafat, E, Laoreti, A, Khalil, A, Costa, F Da Silva, Thilaganathan B. Ophthalmic artery Doppler for prediction of pre-eclampsia: systematic review and meta-analysis. *Ultrasound Obstet Gynecol*. 2018;51(6):731-737. doi:https://doi.org/10.1002/uog.19002
 14. Kane SC, Brennecke SP, da Silva Costa F. Ophthalmic artery Doppler analysis: a window into the cerebrovasculature of women with pre-eclampsia. *Ultrasound Obstet Gynecol*. 2017;49(1):15-21. doi:10.1002/uog.17209
 15. Nicolaides KH, Sarno M, Wright A. Ophthalmic artery Doppler in the prediction of pre-eclampsia. *Am J Obstet Gynecol*. 2022;226(2):S1098-S1101. doi:10.1016/j.ajog.2020.11.039
 16. Kabiru I, Anas I, Mustapha SH, Mansur YA YL. Changes in ophthalmic artery doppler velocimetry in women with pre-eclampsia in Kano, Nigeria. *Ann Afr Med*. 2023;(1) Jan-Ma:26_21. doi:10.4103/aam.aam_26_21.
 17. Rani A, Agarwal P, Tomar R, Rani P. Evaluation of Ophthalmic Artery Doppler : A Window into Cerebrovasculature in Women with Pre-Eclampsia. 2024;16(4):69-77.
 18. Maria T, Pedrazzi C, Sérgio MC, Maria LR, Ricardo PD, Valentino M, Julio AP, José G LR. Maternal ophthalmic artery Doppler ultrasonography in pre-eclampsia and pregnancy outcomes. *Pregnancy Hypertens*. 2017;10(2210-7789):242-246.https://doi.org/10.1016/j.preghy.2017.10.006.
 19. Gyokova E, Hristova-Atanasova E, Iskrov G. Preeclampsia Management and Maternal Ophthalmic Artery Doppler Measurements between 19 and 23 Weeks of Gestation. *J Clin Med*. 2024;13(4). doi:10.3390/jcm13040950
 20. Manchu M, Reddi GV, M. RR. Comparison of ophthalmic artery Doppler indices among hypertensive and normotensive pregnant women in third trimester: association with perinatal outcomes. *Int J Reprod Contraception, Obstet Gynecol*. 2023;12(8):2370-2376. doi:10.18203/2320-1770.ijrcog20232274
 21. Gyokova E, Eleonora HA and GI. Preeclampsia Management and Maternal Ophthalmic Artery Doppler Measurements between 19 and 23 Weeks of Gestation. *Pregnancy Hypertens*. 2023;34(March):124-137. doi:10.1016/j.preghy.2023.11.003
 22. Ozdemir, M.E., Demirci, O., Ozturkmen, H.A., Ulusoy, N.B., Ohanoglu, K. and Cilingir IU. What Is the Role of the Maternal Ophthalmic and Cervical Internal Carotid Arteries in Predicting Maternal Adverse Outcomes in Pre-eclampsia? *J Ultrasound Med*. 2020;39(8):1527-1535.

A Retrospective Analysis of GeneXpert-Detected Tuberculosis and Rifampicin Resistance in a DOTS Clinic of Yobe State University Teaching Hospital Damaturu, Yobe state, Nigeria.Banimoh, O, B.¹, Maktep, Y, D¹. Muhammed, S.¹ Joseph, I, .N.², Gana,M,L.³¹Department of medical microbiology and parasitology, Yobe State University Teaching Hospital, Damaturu, Yobe State, Nigeria.²Department of Obstetrics and Gynaecology, yobe state university teaching hospital Damaturu, Yobe state, Nigeria.³Department of Community Medicine, Yobe State University Teaching Hospital, Damaturu, Yobe State, Nigeria.**Corresponding author: Dr Bello Ozovehe Banimoh, Email: drbellobanimoh@gmail.com**<https://dx.doi.org/10.4314yomj.v2i2.5>

Received: 03-Jul-2026

Accepted: 19-Aug-2026

Published: 31-Aug-2026

Abstract

Background: Tuberculosis (TB) remains a major public health problem in Nigeria, with increasing concerns about rifampicin-resistant TB (RR-TB). The Xpert MTB/RIF assay is routinely used for rapid detection of *Mycobacterium tuberculosis* (MTB) and rifampicin resistance in Directly Observed Treatment Short-course (DOTS) clinics, but local data from Yobe State are scarce. This study aimed to determine the prevalence of Xpert MTB/RIF-detected TB and rifampicin resistance among the DOTS clinic patients. **Methods:** A retrospective review of DOTS clinic and Xpert MTB/RIF registers was conducted from January 2023 to December 2025. *The study utilized only laboratory-based data. The laboratory samples were sputum specimens submitted for Xpert MTB/RIF assay.* All patients with presumptive TB who had Xpert testing during the study period were included. Data on age, sex, test date, MTB result, and rifampicin resistance were extracted. Data were analyzed using SPSS version 26.0 (IBM Corp, Armonk, NY, USA). Associations were assessed using chi-square or Fisher's exact tests. Multivariate binary logistic regression identified independent predictors. Statistical significance was set at $p < 0.05$. **Results:** Of 386 individuals with presumptive tuberculosis, MTB was detected in 153 (39.6%). Among MTB-positive cases, 33 (21.6%) had rifampicin resistance. Males constituted 63.5% of participants, and 25.9% were aged 21–30 years. On multivariate analysis, age 21–30 years (AOR = 2.31, 95% CI: 1.10–4.84, $p = 0.027$), age 31–40 years (AOR = 2.22, 95% CI: 1.02–4.83, $p = 0.045$), and male gender (AOR = 1.56, 95% CI: 1.01–2.43, $p = 0.046$) were independently associated with MTB detection. No significant predictors of rifampicin resistance were identified. **Conclusion:** There is a high burden of TB and considerable RR-TB among patients attending the DOTS clinic at YSUTH. Young adult males had higher odds of MTB detection. Findings highlight the need to strengthen TB control measures, expand rapid molecular diagnostics, and enhance RR-TB surveillance in Yobe State.

Keywords: Tuberculosis; Rifampicin resistance, Xpert MTB/RIF, Nigeria, DOTS, Retrospective study

Cite this article: Banimoh, OB., Maktep, YD. Muhammed, S. Joseph N., Lawan, M G. A Retrospective Analysis of GeneXpert-Detected Tuberculosis and Rifampicin Resistance in a DOTS Clinic of Yobe State University Teaching Hospital Damaturu, Yobe state, Nigeria. Yob Med J.2026;2(2):125-135

Introduction

Tuberculosis (TB) is an infectious disease caused by a highly contagious infectious bacterium called *Mycobacterium tuberculosis* with droplet inhalation as the major route of transmission (1). Tuberculosis (TB) remains a public health challenge in Nigeria and sub-Saharan Africa, Nigeria is known to be among the World Health Organization high TB burden countries (1). Despite the availability of highly effective treatment regimens and reliable rapid diagnostics, >10 million new cases of TB are estimated to occur every year (2).

A major obstacle to reducing the burden of tuberculosis (TB) is the ongoing transmission of infection (2). Most TB transmission studies rely on detecting *Mycobacterium tuberculosis* (MTB) from patient-derived samples such as sputum or bioaerosols generated by an active TB patient at a single time-point (2). However, a major limitation of this approach is that infectious individuals often remain undiagnosed for several weeks to months, during which transmission may occur across multiple community and healthcare settings (3). This makes it difficult to accurately identify locations and patterns of transmission. Consequently, reliance on point-in-time patient sampling may underestimate the true extent of transmission, contribute to sustained community spread, and delay targeted public health interventions (2). In this context, retrospective analyses of routinely generated diagnostic data, such as GeneXpert MTB/RIF results from DOTS clinics, provide valuable insights into trends in TB detection and rifampicin resistance, thereby supporting improved surveillance and programmatic TB control efforts (2). Rifampicin-resistant TB poses a serious threat to TB control due to poor treatment outcomes and increased transmission (3).

Early detection of TB and rifampicin resistance is therefore essential (3).

According to the World Health Organization, an estimated 10.6 million people developed TB globally in 2022, with over 1.3 million TB-related deaths (4). In 2023, an estimated 10.8 million individuals fell ill with TB. (5) The number of newly diagnosed and reported TB cases was 8.2 million, the highest ever recorded, the 2024 WHO Global TB Report highlights the return of tuberculosis (TB) as the leading infectious killer posing substantial public health threats (5).

Sub-Saharan Africa bears a disproportionate burden, largely driven by HIV co-infection and socioeconomic factors (6). Nigeria is among the eight countries that account for more than two-thirds of the global TB burden, with persistent challenges in case detection and treatment outcomes (4).

The early and accurate diagnosis of TB remains critical for disease control. However, conventional smear microscopy has limited sensitivity, particularly in patients with low bacillary loads, leading to missed or delayed diagnoses (7). Furthermore, undetected drug resistance contributes to ongoing transmission and poor treatment outcomes (7).

Since the revolutionary introduction of the Gene Xpert *Mycobacterium tuberculosis*/resistance to rifampicin (MTB/RIF) assay into the field of diagnostic techniques for Tuberculosis (TB), it has been gaining increasing popularity as it offers of MTB detection together with RIF–Resistance in almost two hours with high accuracy, allowing physicians to customize appropriate and accurate treatment regimens without time delay (8).

The GeneXpert MTB/RIF assay is a rapid molecular diagnostic tool recommended by the WHO for the detection of *Mycobacterium tuberculosis* and rifampicin resistance (8).

Although GeneXpert testing is routinely performed at the DOTS clinic of Yobe State University Teaching Hospital, systematic analysis of generated data has not been adequately documented. This study seeks to retrospectively analyze existing GeneXpert records to provide local evidence that will inform TB control strategies and drug-resistant TB surveillance.

This study aimed to retrospectively analyze GeneXpert-detected tuberculosis cases and rifampicin resistance patterns among patients attending the DOTS clinic at Yobe State University Teaching Hospital over a three year period.

Aim of the Study:

To assess the prevalence of GeneXpert-detected tuberculosis and rifampicin resistance among patients attending the DOTS clinic of Yobe State University Teaching Hospital.

Specific Objectives

1. To describe the sociodemographic characteristics of patients tested for TB
2. To determine the proportion of patients with GeneXpert-detected Mycobacterium tuberculosis.
3. To determine the prevalence of rifampicin resistance among GeneXpert-positive TB cases.
4. To determine factors associated with GeneXpert-detected MTB and rifampicin resistance

Methodology:

Study Design

This is a retrospective cross-sectional study.

Study Setting

The study was conducted at the Directly Observed Treatment Short-course (DOTS) clinic of Yobe State University Teaching Hospital, Damaturu, Yobe State, Nigeria.

Study Population

The study included all patients with presumptive tuberculosis who underwent GeneXpert MTB/RIF testing at the Directly

Observed Treatment Short-course (DOTS) clinic of Yobe State University Teaching Hospital, Damaturu, between January 2023 and December 2025. Patients with complete GeneXpert MTB/RIF results were included in the analysis, whereas records with incomplete or missing key information, including MTB detection or rifampicin resistance status, were excluded.

Study Period

January 2023 to December 2025.

Sample Size Determination

All eligible GeneXpert MTB/RIF records within the study period were included. All 386 eligible records meeting inclusion criteria during the study period were included, representing total sampling.

Data Collection Method

Data were extracted solely from laboratory-based records at the DOTS clinics of Yobe State University Teaching Hospital.

The primary source was the GeneXpert MTB/RIF laboratory register (paper-based and electronic) maintained in the TB laboratory. The secondary source for cross-checking demographic details was the accompanying GeneXpert laboratory request forms filled at the time of sputum sample submission. The laboratory specimens were sputum samples submitted for GeneXpert testing.

Data were extracted using a structured data extraction checklist. Variables extracted were patient age, sex, date of sample testing, GeneXpert MTB detection result (detected/not detected), and rifampicin resistance status (detected/not detected/indeterminate). To ensure data quality and accuracy, 10% of the extracted records were independently validated by a second reviewer against the original laboratory register and request forms, with discrepancies resolved by consensus.

Laboratory Methods

GeneXpert MTB/RIF testing was performed as part of routine patient care according to the manufacturer's instructions(9). The assay

detects *Mycobacterium tuberculosis* complex DNA and mutations in the *rpoB* gene associated with rifampicin resistance (10). The diagnosis of tuberculosis and rifampicin resistance was based on results obtained from the GeneXpert MTB/RIF assay conducted at the DOTS clinic in accordance with the guidelines of the National Tuberculosis and Leprosy Control Programme (NTBLCP), Nigeria(9). The GeneXpert MTB/RIF assay is a World Health Organization–endorsed, cartridge-based nucleic acid amplification test routinely used under the NTBLCP for the detection of *Mycobacterium tuberculosis* complex and rifampicin resistance(9,11). All tests were performed as part of standard patient care by trained laboratory personnel prior to this study (11). The entire laboratory procedure was performed using biosafety measures according to the standard laboratory protocol. The interpretation of data from the MTB/RIF tests was software-based and not user-dependent (13). The researchers had no role in specimen collection, testing, or result generation. Data used for this study were extracted retrospectively from the DOTS clinic register without personal patient identifiers

Data Management and Analysis

Extracted data was anonymized and entered into a password-protected computer. Data analysis was performed using SPSS version 26. Descriptive statistics was used to summarize the variables. Associations between categorical variables were assessed using chi-square tests, with statistical significance set at $p < 0.05$.

Results:

Sociodemographic characteristics of the study population

A total of 386 individuals with presumptive tuberculosis (defined per National TB guidelines as individuals with cough ≥ 2 weeks with or without fever, weight loss, night sweats, or history of contact with a known TB case) (14), whose sputum samples

were tested using GeneXpert MTB/RIF assay were included in this analysis. Males constituted majority of the study population [245, 63.5%], while females accounted for 141 [36.5%]. The age of participants ranged from ≤ 20 to >60 years. The most represented age group was 21–30 years with 100 [25.9%] participants, followed by 31–40 years with 74 [19.2%]. Participants aged ≤ 20 years accounted for 61 [15.8%], 41–50 years 53 [13.7%], 51–60 years 50 [13.0%] and >60 years 48 [12.4%] [Table 1].

Prevalence of *Mycobacterium tuberculosis*

Of the 386 sputum samples tested, *Mycobacterium tuberculosis* [MTB] was detected in 153 samples, giving an overall prevalence of 39.6% [Table 2].

Prevalence of rifampicin resistance

Among the 153 GeneXpert MTB-positive cases, rifampicin resistance was detected in 33 cases, representing a prevalence of 21.6%, while 120 [78.4%] were rifampicin sensitive [Table 3].

Factors associated with MTB detection and rifampicin resistance

On bivariate analysis, there was no statistically significant association between age group and MTB detection [$p = 0.126$] or rifampicin resistance [$p = 0.898$]. Similarly, gender was not significantly associated with MTB detection [$p = 0.055$] or rifampicin resistance [$p = 0.713$], although a higher proportion of males [43.3%] had MTB detected compared to females [33.3%] [Table 4].

On multivariate binary logistic regression, after adjusting for gender, age groups 21–30 years [AOR = 2.31, 95% CI: 1.10–4.84, $p = 0.027$] and 31–40 years [AOR = 2.22, 95% CI: 1.02–4.83, $p = 0.045$] were independently associated with MTB detection compared to those aged >60 years as reference. Male gender was also independently associated with MTB detection [AOR = 1.56, 95% CI: 1.01–2.43, $p = 0.046$] compared to female gender [Table 5].

For rifampicin resistance, none of the variables assessed were significant predictors on multivariate analysis. Age group 21–30 years [AOR = 2.06, 95% CI: 0.40–10.57, $p = 0.387$], 31–40 years [AOR = 1.27, 95% CI: 0.22–7.25, $p = 0.787$] and male gender [AOR = 0.82, 95% CI: 0.35–1.91, $p = 0.684$] showed no significant association with rifampicin resistance [Table 5].

HIV status was documented on the laboratory request forms in only 1 case and was therefore excluded from bivariate and multivariate analyses due to substantial missing data and because it was not part of the study objectives.

Socio-demographic characteristics of individuals with presumptive TB whose sputum samples were tested using Xpert MTB/RIF (N=386)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	245	63.5
Female	141	36.5
Age group (years)		
≤20	61	15.8
21–30	100	25.9
31–40	74	19.2
41–50	53	13.7
51–60	50	13.0
>60	48	12.4

Table 2: Prevalence of MTB among presumptive TB cases (Objective 1) (N=386)

GeneXpert MTB result	Frequency (n)	Percentage (%)
Detected	153	39.6
Not detected	233	60.4
Total	386	100.0

Table 3: Prevalence of rifampicin resistance among MTB-positive cases (Objective 2) (N=153)

Rifampicin resistance	Frequency (n)	Percentage (%)
Detected	33	21.6
Not detected	120	78.4
Total	153	100.0

Table 4: Bivariate association between socio-demographic variables and MTB detection and rifampicin resistance (Objective 3)

Variable	MTB Detected n (%)	MTB Not Detected n (%)	RIF Resistant n (%)	RIF Not Resistant n (%)	p-value (MTB / RIF)
Age group					0.126 / 0.898 *
≤20	24 (39.3)	37 (60.7)	5 (20.8)	19 (79.2)	
21–30	47 (47.0)	53 (53.0)	12 (25.5)	35 (74.5)	
31–40	34 (45.9)	40 (54.1)	6 (17.6)	28 (82.4)	
41–50	20 (37.7)	33 (62.3)	4 (20.0)	16 (80.0)	
51–60	14 (28.0)	36 (72.0)	4 (28.6)	10 (71.4)	
>60	14 (29.2)	34 (70.8)	2 (14.3)	12 (85.7)	
Gender					0.055 / 0.713 *
Male	106 (43.3)	139 (56.7)	22 (20.8)	84 (79.2)	
Female	47 (33.3)	94 (66.7)	11 (23.4)	36 (76.6)	

* Fisher's exact test / Chi-square test. HIV status excluded due to incomplete documentation and not being part of study objectives.

Table 5: Multivariate binary logistic regression analysis of factors associated with MTB detection and rifampicin resistance (Objective 3)

Variable	MTB B AOR	95% CI	p-value	RIF AOR	95% CI	p-value
Age group (years)						
≤20	1.709	0.757 – 3.859	0.197	1.544	0.256 – 9.314	0.636
21–30	2.305	1.098 – 4.842	0.027	2.058	0.401 – 10.614	0.387

					10.56 8	
31–40	2.21 6	1.017 –	0.04 5	1.27 2	0.223 –	0.78 7
		4.830			7.247	
41–50	1.56 0	0.673 –	0.30 0	1.43 0	0.221 –	0.70 8
		3.613			9.248	
51–60	1.05 3	0.434 –	0.91 0	2.40 3	0.361 –	0.36 4
		2.552			15.98 0	
>60	1 (Ref)	–	–	1 (Ref)	–	–
Gender						
Male	1.56 4	1.007 –	0.04 6	0.82 2	0.354 –	0.68 4
		2.429			1.908	
Female	1 (Ref)	–	–	1 (Ref)	–	–

AOR: Adjusted Odds Ratio; Ref: Reference category; CI: Confidence Interval

DISCUSSION

The study assessed the prevalence of GeneXpert-detected tuberculosis and rifampicin resistance among patients attending the DOTS clinic of Yobe State University Teaching Hospital, Yobe State, Nigeria. The findings revealed a high prevalence of tuberculosis and a considerable burden of rifampicin resistance among MTB-positive patients, consistent with the epidemiological profile of high TB-burden regions in Africa (15,16).

The prevalence of GeneXpert-detected MTB observed in this study was 39.6%, which is higher than the 22.7% reported in a 9-year retrospective study conducted in Maiduguri, North-East Nigeria, where diagnosis was based primarily on sputum examination (16). Similarly the prevalence obtained in this study was higher than that obtained in a study conducted in National Tuberculosis and Leprosy Training center and referral hospital Zaria north west Nigeria where a prevalence of 23.0% was obtained (17). a significantly lower prevalence was further recorded in a cross sectional study in a District Hospital, North East Ethiopia with a geneXpert detected prevalence of 8.98% (18). Another study conducted in west Bengal India recorded a prevalence of 20.70 % which is

also lower than the prevalence obtained in this study (19).

The disparity in the prevalence is understandable knowing well the genexpert detection is considered more sensitive than sputum examination alone (20). Morealso, a meta-analysis conducted in Ethiopia on the prevalence of Mycobacterium tuberculosis and rifampicin-resistant strains using the GeneXpert MTB/RIF assay reported an overall prevalence of 15%, which is significantly lower than the 39.6% prevalence observed in the present study (21). The higher prevalence that is recorded in this study can be attributed to differences in study setting, population characteristics, TB burden, healthcare access, and diagnostic practices between the two countries (5,14). Additionally, the present study was conducted in a tertiary healthcare facility where patients are more likely to present with advanced disease or strong clinical suspicion of tuberculosis, thereby increasing the likelihood of MTB detection (5,16,21).

This finding indicates a substantial burden of tuberculosis among clinically suspected patients presenting to the DOTS clinic in the study population, consistent with reports from Nigeria that have documented a persistently high prevalence and increasing trend of tuberculosis cases over the years (15).

Furthermore, the high positivity rate may be attributed to the use of GeneXpert testing primarily among symptomatic individuals with strong clinical suspicion of pulmonary tuberculosis, thereby increasing the likelihood of bacteriological confirmation (22).

Similar high MTB detection rates have been reported in several hospital-based studies in Nigeria and other high TB-burden countries in sub-Saharan Africa, reflecting the persistent endemicity of tuberculosis in the region, Nigeria remains one of the countries with the highest TB burden globally and is among the WHO high-burden countries for

tuberculosis, TB/HIV, and multidrug/rifampicin-resistant TB (14).

The relatively high prevalence observed in this study further emphasizes the importance of rapid molecular diagnostic techniques such as GeneXpert MTB/RIF in improving early diagnosis and prompt initiation of treatment (15,19). The World Health Organization continues to recommend molecular rapid diagnostic tests as the initial diagnostic test for tuberculosis because of their superior sensitivity and ability to simultaneously detect rifampicin resistance (23).

The prevalence of rifampicin-resistant tuberculosis among confirmed TB cases 21.6%, which

is concerning and suggests a substantial burden of drug-resistant TB in the study population. This is significantly higher than the overall prevalence of 5.01% reported by Amin et al. in a national health facility-based survey conducted in Egypt (24). Several factors may account for this difference in the disparity of prevalence, Egypt and Nigeria differ considerably in their tuberculosis epidemiology, healthcare infrastructure, and burden of drug-resistant TB such that Egypt has a lower overall TB burden and better TB control indicators compared with Nigeria, which remains one of the WHO high-burden countries for tuberculosis and drug-resistant tuberculosis. More also, the Egyptian study was a national survey involving multiple health facilities and a larger, more representative population, whereas the present study was conducted in the DOTS Clinic of a tertiary referral hospital where more severe, complicated, previously treated, or treatment-failure cases may be concentrated (24). Such referral bias could increase the observed prevalence of rifampicin resistance (1,14,24).

The prevalence of rifampicin-resistant tuberculosis (RR-TB) recorded in this study is comparable to a similar one year retrospective study reported at a tertiary care

hospital in West Bengal, India, where an RR-TB prevalence of 20.86% among confirmed TB cases was documented using the GeneXpert MTB/RIF assay (19). Although the prevalence reported in the Indian study was slightly lower than the 21.6% observed in the present study, the similarity in findings may reflect comparable burdens of drug-resistant tuberculosis among patients presenting to tertiary healthcare facilities, where more complicated and high-risk TB cases are often managed (19).

Furthermore, the prevalence of rifampicin-resistant tuberculosis (RR-TB) observed in this study (21.6%) is relatively lower than 23.4% reported by Olusola Adedeji Adejumo and colleagues among GeneXpert-confirmed tuberculosis patients in a secondary referral hospital in Lagos, Nigeria (25).

The similarity in prevalence estimates despite a relative differences in geographical location and study period may reflect the persistent burden of drug-resistant tuberculosis in Nigeria as a whole (15). Both studies were conducted in referral healthcare facilities where patients with severe disease, treatment failure, relapse, or suspected drug-resistant tuberculosis are more likely to present, thereby increasing the likelihood of detecting rifampicin resistance (15,25). Furthermore, the comparable findings may indicate ongoing challenges in tuberculosis control, including delayed diagnosis, treatment interruption, inadequate treatment adherence, and continued transmission of resistant *Mycobacterium tuberculosis* strains within the community (15,25).

Overall, the discrepancy in this study is most plausibly explained by referral bias rather than a true community surge. As a tertiary referral center, Yobe State University Teaching Hospital concentrates treatment failures, relapses, and complicated TB/HIV cases referred from peripheral DOTS centers, a phenomenon known to overestimate resistance (26). A tertiary facility study in Uganda reported 32.4% RR-TB and

concluded that being conducted at a tertiary referral facility might have overestimated the prevalence of RR owing to referral bias,(27) Furthermore, similar Sahelian and Nigerian referral hospital studies have reported comparable high rates; the rate of detection of *M. tuberculosis* by GeneXpert was 42% and frequency of rifampicin resistance was 20% in Maradi, Niger.(28) Therefore, our 21.6% should be interpreted as a facility-based burden at tertiary level rather than state population prevalence.

The socio-demographic characteristics of the participants showed that males constituted the majority of the study population, accounting for 63.5% of participants. This male predominance is consistent with findings from previous TB studies conducted in Nigeria and globally, similar to this study, there was a marginal to significant male predominance among GeneXpert positive cases in all the studies (15,16,19,24,25), where tuberculosis has consistently been reported to occur more frequently among males than females (20). The reasons for this gender disparity may include greater occupational exposure, increased social interaction, smoking, alcohol use, delayed health-seeking behavior, and differences in healthcare access among males (15,16,19,24,25,29). Biological and immunological factors may also contribute to increased susceptibility among men (29).

The mean age of participants in this study shows that the slightest proportion of participants belonging to the 21–30 years age group, this is in keeping with others similar publication reporting male preponderance indicating that tuberculosis predominantly affects individuals within the economically productive age group (8,9,13,17,24,25).

Although gender did not achieve conventional statistical significance at the bivariate level, male participants demonstrated a higher proportion of MTB positivity compared with females this is consistent with several studies.(13,16,21,24)

Conclusion, this study demonstrated a high prevalence of GeneXpert-detected tuberculosis and a considerable burden of rifampicin resistance among MTB-positive patients attending the DOTS clinic of **Yobe State University Teaching Hospital**. Male gender and younger adult age groups were independently associated with MTB detection, while no significant predictors of rifampicin resistance were identified. These findings underscore the need for strengthened tuberculosis control measures, expansion of rapid molecular diagnostic services, improved adherence monitoring, and enhanced surveillance for drug-resistant tuberculosis in the region.

Limitation; This study has several limitations. First, as this study relied solely on laboratory registers and request forms, clinical information such as patient category [new/relapse/retreatment], treatment history and final treatment outcomes could not be retrieved. Second, HIV status was poorly documented with only 1 positive case, precluding meaningful assessment of TB/HIV association. This may reflect incomplete recording rather than true low prevalence. The absence of detailed clinical, socioeconomic, and behavioral variables limited the assessment of additional factors associated with *Mycobacterium tuberculosis* (MTB) detection and rifampicin resistance. Third, the relatively small number of HIV-positive and rifampicin-resistant cases may have reduced the statistical power of some analyses and limited the precision of the estimates obtained.

Although the study covered multiple years, temporal trend analysis was not performed. This decision was based on the relatively small annual sample sizes, particularly for rifampicin-resistant tuberculosis cases, which could have generated unstable estimates and unreliable year-to-year comparisons. Consequently, trend analysis was avoided to minimize the risk of

overinterpreting findings derived from underpowered data.

Despite these limitations, the study provides valuable local epidemiological evidence on the burden of tuberculosis and the pattern of rifampicin resistance among presumptive tuberculosis patients in Yobe State, thereby contributing important information for tuberculosis control and surveillance efforts in the region.

Informed Consent

Individual informed consent was waived because the study involves retrospective analysis of routinely collected data with no direct patient interaction.

Confidentiality

All data was anonymized prior to analysis. No patient names or unique identifiers were collected. Access to data was restricted to the research team only.

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of Yobe State University Teaching Hospital (YSUTH/HREC/EA/020). The study was conducted in accordance with the Declaration of Helsinki and national ethical guidelines.

Funding

This study was self-funded.

Conflict of Interest

The investigators declare no conflict of interest.

References:

1. Adamu SU, Ojetokun MB, Adamu MB. Effectiveness of Directly Observed Treatment, Short Course (DOTs) Centers in the control of tuberculosis in Niger State, Nigeria. *Niger Health J*. 2024;24(2):1255-1265. doi:10.60787/tnhj.v24i2.808.
2. Verma R, Moreira FMF, do Prado Morais AO, Walter KS, dos Santos PCP, Kim E, et al. Detection of M. tuberculosis in the environment as a tool for identifying high-risk locations for tuberculosis transmission. *Sci Total Environ*. 2022;843:156970. doi:10.1016/j.scitotenv.2022.156970.
3. Prasad R, Gupta N, Banka A. Multidrug-resistant tuberculosis/rifampicin-resistant tuberculosis: Principles of management. *Lung India*. 2018;35(1):78-81. doi:10.4103/lungindia.lungindia_98_17.
4. Al Khatib A, Hassanein S, Almari M, Koubar M, Fakhreddine S. Tuberculosis morbidity and mortality during the COVID-19 pandemic: a life-threatening complex challenge. *Front Cell Infect Microbiol*. 2024;14:1423081. doi:10.3389/fcimb.2024.1423081.
5. Goletti D, Meintjes G, Andrade BB, Zumla A, Lee SS. Insights from the 2024 WHO Global Tuberculosis Report – More comprehensive action, innovation, and investments required for achieving WHO End TB goals. *Int J Infect Dis*. 2025;150:107325. doi:10.1016/j.ijid.2024.107325.
6. Abebe G, Zegeye Bonsa WK. Treatment outcomes and associated factors in tuberculosis patients at Jimma University Medical Center: A 5-year retrospective study. *Int J Mycobacteriol*. 2017;6(3):239-245.
7. Gill CM, Dolan L, Piggott LM, McLaughlin AM. New developments in tuberculosis diagnosis and treatment. *Breathe*. 2022;18(1):210149. doi:10.1183/20734735.0149-2021.
8. Hamed AHG, Ahmed MM, Al Adawy ERA, Maher R. Evaluation of the Gene Xpert Mycobacterium tuberculosis/resistance to rifampicin assay in rapid diagnosis of tuberculosis and identification of rifampin resistance in tuberculous patients. *Egypt J Chest Dis Tuberc*. 2025;74(1):113-120. doi:10.4103/ecdt.ecdt_55_24.
9. Omrani AS, Al-Otaibi MF, Al-Ateah SM, Al-Onazi FM, Baig K, El-Khizzi NA, Albarrak AM. GeneXpert MTB/RIF testing in the management of patients

- with active tuberculosis; a real life experience from Saudi Arabia. *Infect Chemother.* 2014;46(1):30-34. doi:10.3947/ic.2014.46.1.30.
10. Win P, Mi M, Htut M, Su A, Myint Z, Wint W, et al. Detection of I491F and V170F rpoB mutations associated with misdiagnosis of rifampicin resistance among patients with drug-susceptible tuberculosis treatment failure, Myanmar, 2022. *J Glob Antimicrob Resist.* 2025;41:169-172. doi:10.1016/j.jgar.2024.12.026.
 11. Nijman G, Alifia A, Annisa SN, Shurianto L, de Boer IE, Puspitasari I, et al. Operational performance of GeneXpert for tuberculosis diagnosis in West Java province, Indonesia: a public health evaluation. *BMC Health Serv Res.* 2026;26(1):14658. doi:10.1186/s12913-026-14658-0.
 12. Federal Ministry of Health (Nigeria), Department of Public Health, National Tuberculosis, Leprosy and Buruli Ulcer Control Programme. National Guidelines on the Implementation of Truenat Tests for the Detection of Tuberculosis and Rifampicin Resistance. Abuja: Federal Ministry of Health; 2021.
 13. Samuel A, Tongnan N, Ojogba M. A retrospective analysis of Mycobacterium tuberculosis in a tertiary healthcare facility in Jos, North Central Nigeria. *Asian J Res Infect Dis.* 2023;14(3):48-54. doi:10.9734/ajrid/2023/v14i3298.
 14. Li S, Mensah E, Liu M, Pan L, Lu W, Zhou S, Zhang L, Cheng Y, Zhao H, Wei S, Zha L. The burden of tuberculosis and drug resistance in 22 Sub-Saharan African countries, 1990-2021: a GBD 2021 analysis and progress towards WHO 2035 targets with projections to 2050. *Front Microbiol.* 2025;16:1695592. doi:10.3389/fmicb.2025.1695592
 15. Ogunniyi TJ, Abdulganiyu MO, Issa JB, Abdulhameed I, Batisani K. Ending tuberculosis in Nigeria: a priority by 2030. *BMJ Glob Health.* 2024;9(12):e016820. doi:10.1136/bmjgh-2024-016820.
 16. Brisibe F, Jajere SM, Isah RS. Epidemiology of pulmonary tuberculosis in Maiduguri Metropolis, northeastern Nigeria: a hospital-based retrospective study (2003-2012). *Pan Afr Med J One Health.* 2020;2(1):1. doi:10.11604/pamj-oh.2020.2.1.22570.
 17. Abdullahi B, Shaibu MA, Jibrin AU. Gene-Xpert detection of Mycobacterium tuberculosis among patients with suspected cases of pulmonary tuberculosis in National Tuberculosis and Leprosy Training Center and Referral Hospital, Saye-Zaria, Nigeria. *Sci World J.* 2025;20(1):424-430. doi:10.4314/swj.v20i1.57.
 18. Gebretsadik D, Ahmed N, Kebede E, Mohammed M, Belete MA. Prevalence of tuberculosis by automated GeneXpert rifampicin assay and associated risk factors among presumptive pulmonary tuberculosis patients at Ataye District Hospital, North East Ethiopia. *Infect Drug Resist.* 2020;13:1507-1516. doi:10.2147/IDR.S248059.
 19. Pal N, Ray R, Kundu S, Hazra A, Sau S, Sur S, et al. Burden of drug-resistant tuberculosis by the GeneXpert MTB/RIF assay and its clinico-epidemiological aspects at a tertiary care hospital in West Bengal. *Indian J Med Microbiol.* 2024;51:100703. doi:10.1016/j.ijmmmb.2024.100703.
 20. Umair M, Siddiqui SA, Farooq MA. Diagnostic accuracy of sputum microscopy in comparison with GeneXpert in pulmonary tuberculosis. *Cureus.* 2020;12(11):e11383. doi:10.7759/cureus.11383.
 21. Abayneh M, Zeynudin A, Alemu Y, Degefa T, Abamecha A, Tadesse M, et al. The prevalence of Mycobacterium tuberculosis and rifampicin-resistance

- strains using GeneXpert-MTB/RIF assay in Ethiopia: a systematic review and meta-analysis. *BMC Pulm Med.* 2025;25(1):11. doi:10.1186/s12890-024-03452-3.
22. Seid AS, Kaso M. Diagnostic performance of GeneXpert in tuberculosis-HIV co-infected patients at Asella Teaching and Referral Hospital, Southeastern Ethiopia: A cross-sectional study. *PLoS One.* 2021;16(1):e0242205. doi:10.1371/journal.pone.0242205.
23. Aslan G, Ulger M, Ulger ST, et al. Diagnosing tuberculosis: Traditional and new methods against an old enemy. *J Clin Pract Res.* 2024;46(5):431-443. doi:10.14744/cpr.2024.95839.
24. Amin W, Gadallah M, Salah A, Rady M. Prevalence of rifampicin resistance tuberculosis among presumptive tuberculosis patients in Egypt-2021: a national health facility-based survey. *BMC Infect Dis.* 2024;24:210. doi:10.1186/s12879-023-08807-7.
25. Adejumo OA, Olusola-Faleye B, Adepoju V, Bowale A, Adesola S, Falana A, et al. Prevalence of rifampicin resistant tuberculosis and associated factors among presumptive tuberculosis patients in a secondary referral hospital in Lagos Nigeria. *Afr Health Sci.* 2018;18(3):472-478. doi:10.4314/ahs.v18i3.2.
26. Shivekar SS, Kaliaperumal V, Brammacharry U, Sakkaravarthy A, Raj CKV, Alagappan C, et al. Prevalence and factors associated with multidrug-resistant tuberculosis in South India. *Sci Rep.* 2020;10(1):17325. doi:10.1038/s41598-020-74432-y.
27. Baluku JB, Mugabe P, Mulwana R, Nassozi S, Katuramu R, Worodria W. High prevalence of rifampicin resistance associated with rural residence and very low bacillary load among TB/HIV-coinfected patients at the National Tuberculosis Treatment Center in Uganda. *Biomed Res Int.* 2020;2020:2508283. doi:10.1155/2020/2508283.
28. Abdoulaye O, Idi ID, Mahaman Laouali HA, Lawan IM, Boureima H, Mati FG, et al. Evaluation of the resistance of *Mycobacterium tuberculosis* to rifampicin at the Regional Hospital Center of Maradi, Niger Republic. *Int J Mycobacteriol.* 2022;11(4):412-414. doi:10.4103/ijmy.ijmy_162_22.
29. Gupta M, Srikrishna G, Klein SL, Bishai WR. Genetic and hormonal mechanisms underlying sex-specific immune responses in tuberculosis. *Trends Immunol.* 2022;43(8):640-656. doi:10.1016/j.it.2022.06.004.

Determinants of Antenatal Care Utilization among Women of Reproductive Age in Rural Northern Nigeria: Evidence from Bagwai Local Government Area, Kano State

Warshu SH¹, Haruna IU², Braji AI¹, Kwaku AC³, Jalo IR³, Mijinyawa H¹, Maigoro A¹, Getso KI²

¹Department of Community Medicine, Northwest University, Kano State, Nigeria

²Department of Obstetrics and Gynecology, Northwest University, Kano State, Nigeria

³Department of Community Medicine, Bayero University, Kano/Aminu Kano Teaching Hospital, Kano

Corresponding author: Dr Sadiya Haruna Warshu, Email: swarshu@yahoo.com

<https://dx.doi.org/10.4314/yomj.v2i2.6>

Received: 03-Jan-2026

Accepted: 02-Aug-2026

Published: 31-Aug-2026

Abstract

Background: Antenatal care (ANC) is an important component of maternal healthcare and contributes to the early detection and management of pregnancy-related complications. However, continuity of ANC remains suboptimal in many rural settings in northern Nigeria.

Objective: To assess antenatal care utilization and its determinants among women of reproductive age in Bagwai Local Government Area, Kano State, Nigeria.

Methods: A community-based cross-sectional study was conducted among 238 women of reproductive age selected using a multistage sampling technique. Descriptive statistics, Chi-square tests and Binary logistic regression were conducted were used for data analysis. Statistical significance was set at $p < 0.05$.

Results: Awareness of ANC services was high (93.3%). Among women who were aware of ANC, 94.1% attended ANC during their last pregnancy. Of the 209 ANC attendees, 58.9% completed four or more visits. In multivariable analysis, women with parity 1–4 had higher odds of completing four or more ANC visits compared with those with parity ≥ 5 (AOR = 3.83; 95% CI: 1.74–8.44; $p = 0.001$). Women residing less than 30 minutes from a health facility also had higher odds of completing four or more visits (AOR = 2.60; 95% CI: 1.23–5.50; $p = 0.013$). Women younger than 25 years had lower odds of completing four or more visits compared with those aged ≥ 25 years (AOR = 0.32; 95% CI: 0.12–0.86; $p = 0.023$), while women with no formal or primary education had lower odds than those with secondary or tertiary education (AOR = 0.29; 95% CI: 0.16–0.56; $p < 0.001$). Marital type was not independently associated with ANC utilization.

Conclusion: Interventions should focus on improving female education, supporting younger and high-parity women, strengthening primary healthcare services, and reducing geographical barriers to repeated ANC attendance.

Keywords: Antenatal care; utilization; determinants; parity; education; rural women; northern Nigeria.

Cite this article: Warshu SH, Haruna IU, Braji AI, Kwaku AC, Jalo IR, Mijinyawa H. et al. Determinants of Antenatal Care Utilization among Women of Reproductive Age in Rural Northern Nigeria: Evidence from Bagwai Local Government Area, Kano State. Yob Med J.2026;2(2):136-148

Introduction

Maternal mortality continues to be a significant global health issue and a reflection of disparities in healthcare access and quality. According to the World Health Organization, over 90% of global maternal deaths occur in low- and lower-middle-income countries¹. Countries with extremely high maternal mortality rates include South Sudan (1,223 deaths per 100,000 live births), Chad (1,063 deaths), and Nigeria (1,047 deaths)². The United Nations Inter-Agency Estimates¹ reported that although global maternal mortality declined by approximately 40% between 2000 and 2023, an estimated 260,000 women still died from pregnancy- and childbirth-related causes in 2023, with Sub-Saharan Africa accounting for approximately 70% of these deaths.^{1,3}

Nigeria remains one of the countries most severely affected by maternal mortality, with a maternal mortality ratio of 1,047 per 100,000 live births.⁴ This burden underscores the importance of strengthening maternal healthcare across the continuum of pregnancy, childbirth, and the postnatal period.⁵ Antenatal care (ANC) is a key component of maternal healthcare, providing opportunities for early identification and management of pregnancy-related complications, health education, nutritional support, and preparation for childbirth.⁶

The earlier WHO Focused Antenatal Care (FANC) model recommended at least four ANC visits during pregnancy.⁷ In 2016, WHO replaced this with a minimum of eight ANC contacts to improve care quality and the pregnancy experience.^{8–10} The current model recommends initiation of ANC within the first 12 weeks of gestation, followed by contacts at 20, 26, 30, 34, 36, 38, and 40 weeks.¹

Despite these recommendations, ANC utilization remains suboptimal in many low-resource settings. Approximately 69% of pregnant women in Sub-Saharan Africa receive at least one ANC visit, while many do

not achieve the recommended number of contacts.¹¹ Coverage of at least four ANC visits is particularly low in West and Central Africa (56%) compared with high-income regions.³ Maternal education, socioeconomic status, geographic accessibility, and other sociodemographic and behavioral factors have been identified as important determinants of ANC utilization.^{12,13}

In Nigeria, the NDHS 2023 reported that 63% of women with a live birth in the two years preceding the survey received ANC from a skilled provider. However, only 43% of live births and 51% of stillbirths were delivered in health facilities, and less than half received skilled attendance at birth¹⁴. These figures highlight persistent inequalities between awareness and actual utilization of maternal health services.

Improving ANC utilization is essential to Nigeria's progress towards Sustainable Development Goal 3, which seeks to reduce the maternal mortality ratio to fewer than 70 per 100,000 live births by 2030.³ This study therefore assessed ANC awareness and utilization and identified factors associated with completing at least four ANC visits among women of reproductive age in Bagwai Local Government Area, Kano State, to provide locally relevant evidence for maternal health interventions in rural northern Nigeria.

Nigeria faces a significant challenge in achieving Sustainable Development Goal (SDG) 3, which aims to reduce maternal mortality to fewer than 70 per 100,000 live births by 2030³. Improving ANC coverage and adherence is crucial for reaching this goal, as ANC remains the main platform for preventing complications and ensuring safe deliveries. This study examined ANC awareness, utilization, and factors influencing attendance among women of reproductive age in Bagwai Local Government Area, Kano State, to provide locally relevant evidence to guide maternal health interventions in rural northern Nigeria.

Methods**Study area**

The study was conducted in Bagwai LGA, located in northern Kano State, Nigeria, between latitudes 11°48'N and 12°03'N, and longitudes 8°20'E and 8°40'E. It is bordered by Tsanyawa to the north, Gwarzo to the east, Ghari to the west, and Bichi to the south, with its headquarters in Bagwai town. The area falls within the Sudan savanna zone, characterized by a tropical continental climate with distinct wet and dry seasons. The main occupations include farming, fishing, and trading, supported by Watari Dam, which supplies water for irrigation and domestic use. The population is primarily Hausa and Fulani, and Islam is the predominant religion.

Study population

Women of reproductive age who were permanent residents of Bagwai Local Government Area and who had experienced at least one pregnancy were eligible to participate in the study. Eligible women were required to have resided in the selected community for at least six months prior to the study and to provide informed consent.

Women who were temporary visitors to the selected communities, those who had never been pregnant, and women who were too ill to participate in the interview at the time of data collection were excluded from the study.

Study Design

This was a community-based cross-sectional study.

Sample size estimation

The following sample size formula was employed

$$n = Z^2 p(1-p)/d^2 \text{ }^{15}.$$

with $Z=1.96$ (95% confidence) and absolute precision $d=0.05$

Using an expected prevalence, $p= 63\%$ of women receive ANC from a skilled provider¹⁴

$$N= 1.96 \times 1.96 \times 0.63(1-0.63)/0.05^2$$

$$=3.84 \times 0.63 \times 0.37/0.0025$$

$$=358$$

To account for an anticipated 10% non-response, 10% of the calculated sample size was added:

$$0.10 \times 358 = 35.8$$

$$= 358 + 35.8 = 393.8$$

The final target sample size was therefore approximately 394 participants. However, 238 eligible women ultimately participated in the study, representing 60.4% of the target sample size.

Sampling Technique

Participants were selected using a multistage sampling technique covering different wards within Bagwai LGA. House numbering and household listing were done initially to get the total number of household heads. This formed our sampling frame. Systematic random sampling was employed to sample the eligible households. The number of eligible households was divided by the sample size to determine the sampling interval. A random start was made using a random sampling method. Sampling continued systematically at the specified interval throughout the data-collection period. Of the targeted 394 participants, 238 consented and completed the study.

Data collection

Data were collected in December 2025 using a structured interviewer-administered questionnaire that captured sociodemographic characteristics, ANC attendance, and barriers to utilization. Data were collected by medical students who were trained on how to collect the data and come up with a uniform interpretation of terms.

Data analysis

Data were entered into an Excel spreadsheet and subsequently exported to SPSS version 25¹⁶. Data were analyzed using descriptive statistics and chi-square tests to assess the associations between ANC utilization and independent variables, including education, age, parity, and distance to the facility. Binary logistic regression

was performed to identify independent predictors of completing at least four ANC visits. Variables considered clinically relevant and/or associated with the outcome at the bivariate level were entered into the multivariable model. Adjusted odds ratios (AORs) with 95% confidence intervals were reported, and statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval was obtained from the Research and Ethics Committee of the Kano State Ministry of Health (NHREC/17/03/2018). Permission was also obtained from the District Head of Bagwai and the Chairman of the Local Government Area. Written informed consent was obtained from all participants before data collection. Participants were assured of confidentiality, anonymity, and their right to withdraw from the study at any time without penalty.

Results

Table 1: Socio-Demographic Characteristics of Respondents (n = 238)

VARIABLE	FREQUENCY(n)	PERCENTAGE(%)
Age group		
<25	34	14.3
≥ 25	204	85.7
Mean	32.3	
±8.9yrs		
Occupation		
Petty trader	171	71.8
Housewife	28	11.8
Farmers	12	5.0
others	27	11.3
Husbands' occupation		
Farmer	105	44.1
Artisan	66	27.7
Civil servant	27	11.3
others	40	16.8
Level of education		
Primary	80	33.6
Secondary	105	44.1
Tertiary	8	3.4
No formal education	45	18.9
Type of marriage		
Monogamous	147	61.8
Polygamous	91	38.2
Number of times married		
Once	190	79.8
More than once	48	20.2

Table 2: Obstetric History of Respondents(n=238)

Variable	Frequency (n)	Percentage (%)
Age at first pregnancy (years)		
≤17	87	36.6
≥18	151	63.4
Parity		
≤4	75	31.5
5 & above	163	68.5
Mean 6.16 ± 3.5		
Current pregnancy status		
Pregnant	31	13.0
Not pregnant	207	87.0
History of stillbirth		
Yes	43	18.1
No	195	81.9
History of miscarriage		
Yes	58	24.4
No	180	75.6

Table 3: Awareness and Utilization of Antenatal Care (ANC)

Variable	Frequency (n)	Percentage (%)
Awareness of ANC services		
Yes	222	93.3
No	16	6.7
Attended ANC during last pregnancy(n=222)		
Yes	209	94.1
No	13	5.9
Number of ANC visits during last pregnancy (n=209)		
<4	86	41.1
≥4	123	58.9
Place of ANC(n=209)		
Government PHC	179	85.6
Private/Other	30	14.4
Distance from ANC facility		
<30 minutes	58	26.1
≥30 minutes	164	57.2
Reasons for not attending ANC(n=13)		

Variable	Frequency (n)	Percentage (%)
No perceived need	9	69.2
Cultural restrictions	3	23.1
Distance/transport	4	30.8
Financial constraint	4	30.8
Husband's permission	5	38.5
Lack of facility in the community	2	15.4
Don't know how to access the service	3	23.1

* Percentages exceed 100% because multiple responses were allowed

Table 4: Delivery and Postnatal Practices

Variable	Frequency (n)	Percentage (%)
Place of last delivery (n= 238)		
Home	167	70.2
Health facility	71	29.8
Reasons for home delivery (n = 167)		
Traditional belief	79	47.3
Easy access / convenience	79	47.3
Cost	9	5.4
Skilled assistance at birth (n= 238)		
No assistance	83	34.9
Traditional birth attendant	31	13.0
Health professional**	64	26.9
Relative / friend	60	25.2
Attended PNC after last delivery (n = 238)		
Yes	138	58.0
No	100	42.0
PNC services received (n= 138)		
Immunization for baby	54	39.1
Blood pressure measurement	13	9.4
Examination of abdomen	10	7.2
Examination of child	25	18.1
Family-planning education	7	5.1
Breastfeeding education	10	7.2
Treatment / review of problems	7	5.1

* Percentages exceed 100% because multiple responses were allowed.

** Health professional includes doctors, nurses, and midwives.

Table 5: Factors Associated with Adequate ANC Utilization

Variable	χ^2	df	p-value
Age (<25 vs ≥25 years)	0.440	1	0.507
Educational level (No formal/Primary vs Secondary/Tertiary)	24.534	1	<0.001
Marital type (Monogamous vs Polygamous)	5.277	1	0.022
Parity (1–4 vs ≥5)	12.142	1	<0.001
Distance to health facility (<30 vs ≥30 minutes)	8.237	1	0.004
Occupation	1.450	3	0.694

Table 6: Multivariable Logistic Regression Analysis of Factors Associated with Adequate ANC Utilization

Predictor	Category	AOR	95% CI	P-value
Age (years)	<25	0.32	0.12–0.86	0.023
	≥25	1.00	Reference	
Educational level	No formal/Primary	0.29	0.16–0.56	<0.001
	Secondary/Tertiary	1.00	Reference	
Marital type	Monogamous	1.63	0.85–3.14	0.144
	Polygamous	1.00	Reference	
Parity	1–4	3.83	1.74–8.44	0.001
	≥5	1.00	Reference	
Distance to health facility	<30 minutes	2.60	1.23–5.50	0.013
	≥30 minutes	1.00	Reference	

In total, 238 women were successfully interviewed, giving a response rate of 60.4%. This shortfall is acknowledged as a study limitation. The mean age of the respondents was 32.3 ± 8.9 years, with the majority (85.7%) aged 25 years or older. Most respondents were petty traders (71.8%), while farming was the predominant occupation among their husbands (44.1%). Regarding educational attainment, 44.1% had secondary education, 33.6% had primary education, 18.9% had no formal education, and only 3.4% had tertiary education. Most respondents were in monogamous marriages (61.8%), and 79.8% had been married only once (Table 1).

Regarding obstetric characteristics, 36.6% of respondents had their first pregnancy at age 17 or younger. The mean parity was 6.16 ± 3.5 , with more than two-thirds (68.5%) having a parity of five or more. At the time of the study, 13.0% of respondents were pregnant. A history of stillbirth was reported by 18.1% of respondents, while 24.4% had experienced a miscarriage. (Table 2)

Awareness of antenatal care (ANC) services was high, with 222 (93.3%) respondents reporting awareness of ANC services. Among these women, 209 (94.1%) attended ANC during their last pregnancy. Of the 209 ANC attendees, 123 (58.9%) had four or more ANC visits, while 86 (41.1%) had fewer than four visits. Most ANC attendees (85.6%) received care at government primary healthcare facilities.

Among the 13 women who did not attend ANC, the most commonly reported reason was a perceived lack of need for ANC (69.2%). Other barriers included lack of husband's permission (38.5%), distance or transportation difficulties (30.8%), financial constraints (30.8%), cultural restrictions (23.1%), lack of knowledge about how to access ANC services (23.1%), and absence of a health facility in the community (15.4%).(Table 3)

Most respondents (70.2%) delivered at home, mainly due to traditional beliefs and convenience. Roughly two-thirds (73.1%) had no skilled assistance at delivery, while 26.9% were assisted by health professionals. Postnatal care attendance was moderate (58.0%), with infant immunization being the most common service received (39.1%). (Table 4)

Bivariate analysis showed that educational level, marital type, parity, and distance to the

health facility were significantly associated with adequate ANC utilization. Adequate ANC utilization was substantially higher among women with secondary or tertiary education than among those with no formal or primary education (75.5% vs. 41.7%; $\chi^2 = 24.534$, $p < 0.001$). Women with parity 1–4 were also more likely to have adequate ANC utilization than those with parity ≥ 5 (76.1% vs. 50.7%; $\chi^2 = 12.142$, $p < 0.001$). Similarly, adequate ANC utilization was higher among women residing < 30 minutes from a health facility than among those residing ≥ 30 minutes away (75.0% vs. 52.9%; $\chi^2 = 8.237$, $p = 0.004$). Women in monogamous marriages had higher adequate ANC utilization than those in polygamous marriages (64.9% vs. 48.7%; $\chi^2 = 5.277$, $p = 0.022$). Age ($\chi^2 = 0.440$, $p = 0.507$) and occupation ($\chi^2 = 1.450$, $p = 0.694$) were not significantly associated with adequate ANC utilization at the bivariate level.

In the multivariable logistic regression analysis, age, educational level, parity, and distance to the health facility remained independently associated with adequate ANC utilization. Women with parity of 1–4 had nearly four times the odds of adequate ANC utilization compared with women with parity ≥ 5 (AOR = 3.83; 95% CI: 1.74–8.44; $p = 0.001$). Similarly, women residing less than 30 minutes from a health facility had approximately 2.6 times the odds of adequate ANC utilization compared with those residing ≥ 30 minutes away (AOR = 2.60; 95% CI: 1.23–5.50; $p = 0.013$). Women aged < 25 years had lower odds of adequate ANC utilization compared with those aged ≥ 25 years (AOR = 0.32; 95% CI: 0.12–0.86; $p = 0.023$). Likewise, women with no formal or primary education had lower odds of adequate ANC utilization than those with secondary or tertiary education (AOR = 0.29; 95% CI: 0.16–0.56; $p < 0.001$). Marital type was not independently associated with adequate ANC utilization (AOR = 1.63; 95% CI: 0.85–3.14; $p = 0.144$).

Discussion

This study assessed antenatal care (ANC) utilization and its determinants among women of reproductive age in rural Bagwai Local Government Area of Kano State. Awareness and initial uptake of ANC were high, with 93.3% of respondents being aware of ANC services and 94.1% of those aware reporting attendance during their last pregnancy. However, among women who attended ANC, only 58.9% had four or more visits. This indicates that high awareness and initial contact with ANC services do not necessarily translate into continuity of care. Similar gaps between initial ANC attendance and completion of the recommended number of visits have been reported in Nigeria, Ghana, and Uganda.^{14,17,18}

The high level of ANC awareness observed in this study may reflect the contribution of health education and maternal health promotion through primary healthcare services. Indeed, most women who utilized ANC received care at government primary healthcare facilities, underscoring the important role of PHC facilities in delivering maternal health services in rural communities. Nevertheless, the finding that a substantial proportion of women did not complete four ANC visits suggests that awareness alone is insufficient to ensure adequate utilization. Accessibility, socioeconomic circumstances, reproductive experience, and other household-level factors may influence continued attendance.

Educational attainment was strongly associated with ANC utilization. Women with no formal or only primary education had approximately 71% lower adjusted odds of having four or more ANC visits compared with women who had secondary or tertiary education (AOR = 0.29; 95% CI: 0.16–0.56). This is consistent with evidence from Nigeria and other sub-Saharan African settings demonstrating greater utilization of maternal healthcare among women with higher educational attainment.^{19–21} Education may improve health literacy and women's understanding of the preventive value of ANC, including the importance of continued attendance even in the absence of pregnancy-related symptoms. Education may also enhance women's ability to obtain and interpret health information and participate in decisions concerning their healthcare. The finding reinforces the broader

maternal health benefits of improving female education, particularly in rural communities

Parity was another important independent predictor. Women with a parity of 1–4 had nearly four times the adjusted odds of having four or more ANC visits compared with women with a parity of five or more (AOR = 3.83; 95% CI: 1.74–8.44). This finding agrees with previous studies showing that women with higher parity are less likely to utilize ANC services consistently.^{19,22–24}

High-parity women may perceive themselves as experienced with pregnancy and consequently consider repeated ANC visits less necessary, particularly in the absence of complications. Competing responsibilities associated with caring for several children may also make repeated clinic attendance more difficult. These findings suggest that health education during community outreach and ANC contacts should specifically emphasize that previous uncomplicated pregnancies do not eliminate the need for appropriate care in subsequent pregnancies.

Distance to the health facility remained independently associated with adequate ANC utilization. Women living closer to an ANC facility were more likely to complete at least four visits, supporting evidence that distance remains a major barrier to maternal healthcare in rural settings. Travel over long distances may impose transportation costs, require substantial time away from household or income-generating activities, and become particularly difficult as pregnancy advances.^{25–27} The importance of proximity in this study therefore points to the need to strengthen maternal health services at primary healthcare facilities, improve outreach to underserved communities, and address transportation barriers for women living far from health facilities.

Age was not significantly associated with adequate ANC utilization at the bivariate level but became significant after adjustment for other factors. The emergence of this association after adjustment suggests that the relationship between age and ANC utilization may have been influenced by other characteristics, particularly parity, education, marital structure, and geographical accessibility. Younger women may have less experience navigating maternal healthcare services and may also have less autonomy or fewer resources to facilitate

repeated attendance. This finding highlights the importance of ensuring that younger women receive appropriate support and counselling to maintain ANC attendance throughout pregnancy. Marital type was significantly associated with ANC utilization at the bivariate level, with women in monogamous marriages having higher utilization than those in polygamous marriages. However, this association was attenuated and was no longer statistically significant after adjustment for other factors (AOR = 1.63; 95% CI: 0.85–3.14). This suggests that the observed crude association between marital structure and ANC utilization may be partly explained by differences in other characteristics such as education, parity, age, or accessibility rather than marital type itself. However, other studies have revealed a relationship between household or marital characteristics and maternal healthcare utilization²⁸. Differences in household decision-making, competing responsibilities, and access to financial or spousal support may contribute to this association. However, these mechanisms were not directly assessed in the present study and should therefore be interpreted cautiously. Consequently, marital type should not be interpreted as an independent determinant of ANC utilization in this study.

Among women who did not attend ANC, lack of perceived need was the most frequently reported reason. Other reported barriers included lack of husband's permission, distance or transportation difficulties, financial constraints, cultural restrictions, and limited knowledge of how to access services. Although the number of ANC non-attendees was small, these findings illustrate the range of individual, household, sociocultural, and health-system factors that may influence maternal healthcare utilization. The role of husbands' permission is particularly relevant in settings where household healthcare decisions may involve male partners. This matches findings from studies in northern Nigeria and other patriarchal societies where male approval continues to be a key factor influencing maternal health service use^{20,29,30}. Increasing male involvement and couple-centered health education could therefore promote women's autonomy and boost ANC participation.

Despite the high level of ANC awareness and attendance observed, a substantial disconnect remained between antenatal care and subsequent

delivery practices. Most respondents delivered their last child at home, and only a minority were assisted by a health professional. The findings also demonstrate that contact with ANC services does not necessarily translate into facility-based delivery or skilled attendance at birth. Despite relatively high ANC attendance, home delivery remained common in the study population, with traditional beliefs and convenience influencing the choice of place of delivery. More than 50% of births in developing countries occur at home³¹. This aligns with findings in Kaduna,³² where over half (51.9%) of the rural women delivered at home. This finding, however, differs from that of Johnson et al. in southwestern Nigeria, where 64.9% of the last deliveries occurred in health facilities.³³ Most maternal and neonatal deaths are linked to the preference for delivering outside of hospitals³⁴. Many of these deaths could be prevented with access to skilled birth attendants^{35,36}. Access to health facilities from one's residence significantly determines where delivery occurs.¹⁹ A study in the Eastern Region of Ghana reported that each additional kilometer of distance decreased the likelihood of women giving birth in health facilities by 6.7%.³⁷

Overall, the findings demonstrate that completion of four or more ANC visits in this rural population was influenced by interacting educational, reproductive, demographic, and geographical factors. Higher educational attainment, lower parity, age of 25 years or older, and shorter travel time to a health facility were independently associated with greater ANC utilization. Interventions aimed at improving continuity of ANC should therefore extend beyond increasing awareness and address barriers to repeated attendance, with particular attention to women with limited education, high parity, younger women, and those living farther from health facilities. Addressing these determinants is essential for improving maternal health outcomes and achieving SDG 3 targets in Nigeria

Discussion

This study demonstrates an important gap between awareness of antenatal care (ANC) and sustained utilization among women in rural northern Nigeria. Although awareness and initial attendance were high, continuation of care was less consistent. This pattern suggests that awareness alone may not be sufficient to ensure continued ANC attendance. Similar gaps between

initial access and continued utilization have been reported in Nigeria, Ghana, and Uganda.^{14,17,18} The finding is particularly important in the context of the current WHO recommendation of eight ANC contacts, which requires substantially greater continuity of care than the former four-visit Focused Antenatal Care model.¹⁰

The observed gap between awareness and continued attendance may reflect barriers that arise after women have recognized the importance of ANC. Geographic accessibility, financial constraints, cultural considerations, and the need for spousal permission were among the barriers reported by respondents. Studies in northern Nigeria and Ghana have similarly identified traditional beliefs and limited accessibility as important constraints to maternal healthcare utilization.^{22,23} These findings suggest that interventions focused solely on increasing awareness may have limited impact unless the practical and sociocultural barriers.

Maternal education emerged as an important independent predictor of completing at least four ANC visits. This is consistent with evidence from Nigeria and other sub-Saharan African settings demonstrating greater utilization of maternal healthcare among women with higher educational attainment.^{19–21} Education may improve health literacy and women's understanding of the preventive value of ANC, including the importance of continued attendance even in the absence of pregnancy-related symptoms. Education may also enhance women's ability to obtain and interpret health information and participate in decisions concerning their healthcare. The finding reinforces the broader maternal health benefits of improving female education, particularly in rural communities.

Marital structure was also associated with ANC utilization, with women in monogamous marriages more likely to complete at least four visits. Similar relationships between household or marital characteristics and maternal healthcare utilization have been reported elsewhere.²⁸ Differences in household decision-making, competing responsibilities, and access to financial or spousal support may contribute to this association. However, these mechanisms were not directly assessed in the present study and should therefore be interpreted cautiously. Nevertheless, the finding highlights the potential

importance of household context in influencing women's ability to maintain ANC attendance.

Parity was another important predictor of ANC utilization, with lower-parity women demonstrating better continuity of attendance. This finding agrees with previous studies showing that women with higher parity are less likely to utilize ANC services consistently.^{19,22–24} High-parity women may perceive themselves as experienced following previous pregnancies and consequently consider repeated ANC attendance less necessary, particularly when previous pregnancies were uncomplicated. They may also face greater childcare and household responsibilities, making repeated visits to health facilities more difficult. Maternal health education should therefore emphasize that each pregnancy carries potential risks irrespective of previous pregnancy experience.

Geographical accessibility was particularly important in determining ANC utilization. Women living closer to an ANC facility were more likely to complete at least four visits, supporting evidence that distance remains a major barrier to maternal healthcare in rural settings. Travel over long distances may impose transportation costs, require substantial time away from household or income-generating activities, and become particularly difficult as pregnancy advances.^{25–27} The importance of proximity in this study therefore points to the need to strengthen maternal health services at primary healthcare facilities, improve outreach to underserved communities, and address transportation barriers for women living far from health facilities.

The findings also demonstrate that contact with ANC services does not necessarily translate into facility-based delivery or skilled attendance at birth. Despite relatively high ANC attendance, home delivery remained common in the study population, with traditional beliefs and convenience influencing the choice of place of delivery. More than 50% of births in developing countries occur at home³¹. This aligns with findings in Kaduna,³² where over half (51.9%) of the rural women delivered at

home. This finding, however, differs from that of Johnson et al. in southwestern Nigeria, where 64.9% of the last deliveries occurred in health facilities.³³ Most maternal and neonatal deaths are linked to the preference for delivering outside of hospitals³⁴. Many of these deaths could be prevented with access to skilled birth attendants^{35,36}. Access to health facilities from one's residence significantly determines where delivery occurs.¹⁹ A study in the Eastern Region of Ghana reported that each additional kilometer of distance decreased the likelihood of women giving birth in health facilities by 6.7%.³⁷

Several respondents pointed out that the lack of their husbands' permission or support affects their ability to attend ANC, highlighting ongoing gender-related barriers to maternal healthcare access in northern Nigeria. In many households, women need their husbands' approval to seek care, and the absence of permission can delay or hinder ANC attendance. This matches findings from studies in northern Nigeria and other patriarchal societies where male approval continues to be a key factor influencing maternal health service use^{20,29,30}. Increasing male involvement and couple-centered health education could therefore promote women's autonomy and boost ANC participation.

Limitation

This study has several limitations. First, the cross-sectional design precludes causal inference regarding the identified factors associated with ANC utilization. Second, information on previous pregnancies and ANC attendance was self-reported and may therefore be subject to recall and social desirability bias. In addition, 238 of the targeted 394 participants were recruited, representing 60.4% of the planned sample size. This shortfall may have reduced the statistical power of the study and introduced selection bias if women who participated differed systematically from those who did not. Finally, ANC utilization was assessed

based on completion of at least four visits, reflecting the former WHO Focused Antenatal Care model rather than the current recommendation of eight ANC contacts. These limitations should be considered when interpreting the findings.

Conclusion

Although ANC awareness and initial attendance were high, continuity of care remained suboptimal. Educational attainment, parity, age, and proximity to health facilities were independent determinants of completing four or more ANC visits. Interventions should therefore prioritize women with limited education, high parity, younger women, and those living farther from health facilities, while strengthening primary healthcare services and reducing barriers to repeated ANC attendance.

Conflict of Interest Statement

The authors declare no conflict of interest relevant to this study.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. World Health Organisation. Maternal Mortality: Key facts [Internet]. 2025. Available from: <https://www.who.int/news-room/fact-sheets/detail/maternal-mortality>
2. African Health Observatory (AHO). Maternal mortality: Regional fact sheet [Internet]. World Health Organization; 2023. Available from: https://files.aho.afro.who.int/afahobckpcontainer/production/files/iAHO_Maternal_Mortality_Regional_Factsheet.pdf
3. Maternal mortality rates and statistics. UNICEF Data [Internet]. United Nations Children's Fund (UNICEF); 2024. Available

from: <https://data.unicef.org/topic/maternal-health/maternal-mortality>

4. WHO. Trends in maternal mortality estimates 2000 to 2023: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2025.

5. National Population Commission (NPC) [Nigeria] and ICF. Nigeria Demographic and Health Survey 2018: NPC and ICF. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF; 2019.

6. Garg P. Knowledge, attitude and practice of antenatal care among pregnant women attending antenatal clinic in a tertiary care hospital of Mathura, Uttar Pradesh, India. *Int J Reprod Contracept Obstet Gynecol*. 2020 May 27;9(6):2269. doi:10.18203/2320-1770.ijrcog20202072

7. Sarker BK, Rahman M, Rahman T, Rahman T, Khalil JJ, Hasan M, et al. Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh. Navaneetham K, editor. *PLOS ONE*. 2020 Nov 5;15(11):e0241185. doi:10.1371/journal.pone.0241185

8. Benova L, Tunçalp Ö, Moran A, Campbell O. Not just a number: examining coverage and content of antenatal care in low-income and middle-income countries. *BMJ Glob Health*. 2018;3(e000779).

9. Organisation mondiale de la santé, editor. *World health statistics 2019: monitoring health for the SDGs sustainable development goals*. Geneva: World health organization; 2019.

10. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva, Switzerland: World Health Organization; 2016. 1 p.

11. Vogel J, Souza J, Gülmezoglu A, Mori R, Lawn J. Antenatal care. In: Opportunities for Africa's newborns: Practical data, policy and programmatic support for newborn care in Africa [Internet]. Partnership for Maternal, Newborn & Child Health & World Health Organization; 2006. Available from: <https://www.who.int/pmnch/media/publications/oanfullreport.pdf>

12. Alukagberie ME, Elmusharaf K, Ibrahim N, Poix S. Factors associated with adolescent pregnancy and public health interventions to address in Nigeria: a scoping review. *Reprod Health*. 2023 Jun 24;20(1):95. doi:10.1186/s12978-023-01629-5

13. Anaba EA, Alor SK, Badzi CD. Utilization of antenatal care among adolescent and young mothers in Ghana; analysis of the 2017/2018 multiple indicator cluster survey. *BMC Pregnancy Childbirth*. 2022 Dec;22(1):544. doi:10.1186/s12884-022-04872-z

14. Federal Ministry of Health and Social Welfare of Nigeria (FMoHSW), National Population Commission (NPC) [Nigeria], and ICF. Nigeria Demographic and Health Survey 2023–24: Key Indicators Report. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF: Nigeria National Population Commission and ICF Macro Abuja; 2023.

15. Araoye M. Sample size determination in Research Methodology with Statistics for Health and Social Sciences. In: Subject Selection. Nathadex Publishers, Ilorin; 2004. 115–21 p.

16. IBM Corp. IBM SPSS Statistics for Windows. Armonk, NY, USA; 2017.

17. Boah M, Mahama AB, Ayamga EA. They receive antenatal care in health facilities, yet do not deliver there: predictors of health facility delivery by women in rural Ghana. *BMC*

Pregnancy Childbirth. 2018 Dec;18(1):125. doi:10.1186/s12884-018-1749-6

18. Anastasi E, Borchert M, Campbell OMR, Sondorp E, Kaducu F, Hill O, et al. Losing women along the path to safe motherhood: why is there such a gap between women's use of antenatal care and skilled birth attendance? A mixed methods study in northern Uganda. *BMC Pregnancy Childbirth*. 2015 Dec;15(1):287. doi:10.1186/s12884-015-0695-9

19. Alatinga KA, Affah J, Abihiro GA. Why do women attend antenatal care but give birth at home? a qualitative study in a rural Ghanaian District. Dasvarma GL, editor. *PLOS ONE*. 2021 Dec 16;16(12):e0261316. doi:10.1371/journal.pone.0261316

20. Fagbamigbe AF, Idemudia ES. Barriers to antenatal care use in Nigeria: evidences from non-users and implications for maternal health programming. *BMC Pregnancy Childbirth*. 2015;15(95).

21. Ibrahim F, Dessie Y, Assefa N, Getahun T. Birth Preparedness and Complication Readiness among Pregnant Women Attending Antenatal Care Clinics in Public Health Facilities, Harari Region, Eastern Ethiopia. *East Afr J Health Biomed Sci*. 2020;4(2):15–26.

22. Dickson KS, Darteh EKM, Kumi-Kyereme A, Ahinkorah BO. Determinants of choice of skilled antenatal care service providers in Ghana: analysis of demographic and health survey. *Matern Health Neonatol Perinatol*. 2018 Dec;4(1):14. doi:10.1186/s40748-018-0082-4

23. Opara UC, Iheanacho PN, Petrucka P. Cultural and religious structures influencing the use of maternal health services in Nigeria: a focused ethnographic research. *Reprod Health*. 2024 Dec 18;21(1):188. doi:10.1186/s12978-024-01933-8

24. Wang W, Alva S, Wang S, Fort A. Levels and trends in the use of maternal health services in developing countries. [DHS Comparative Reports]. Calverton, Maryland, USA: ICF Macro.: United States Agency for International Development (USAID).; 2011. DHS Comparative Reports no.: 26.

25. Khan MdN, Alam MdB, Chowdhury AR, Kabir MdA, Khan MdMA. Availability and readiness of healthcare facilities and their effects on antenatal care services uptake in Bangladesh. *BMC Health Serv Res*. 2024 Apr 5;24(1):431. doi:10.1186/s12913-024-10824-4

26. Lateef MA, Kuupiel D, Mchunu GG, Pillay JD. Utilization of Antenatal Care and Skilled Birth Delivery Services in Sub-Saharan Africa: A Systematic Scoping Review. *Int J Environ Res Public Health*. 2024 Apr 3;21(4):440. doi:10.3390/ijerph21040440

27. Nyathi L, Tugli AK, Tshitangano TG, Mpofu M. Investigating the accessibility factors that influence antenatal care services utilisation in Mangwe district, Zimbabwe. *Afr J Prim Health Care Fam Med*. 2017 Jun 29;9(1). doi:10.4102/phcfm.v9i1.1337

28. Doctor HV, Tukur D. Utilization of Non-Skilled Birth Attendants in Northern Nigeria: A Rough Terrain to the Health-Related MDGs. *Afr J Reprod Health*. 2010;14(2):37–45.

29. Ezemenahi I, Modebe A, Okpara U, Ezemenahi S, Obi-Nwosu L, Ezemenahi E. Male Involvement in the Maternal Utilization of Health Services among childbearing Women in Tertiary Healthcare Outstations in South-East Nigeria. *Orient J Med*. 2024;36(3–4):1. doi:https://doi.org/10.5281/zenodo.13902697

30. Sinai I, Azogu O, Dabai SS, Waseem S. Role of men in women's health service utilisation in northern Nigeria: a qualitative study of women, men and provider perspectives. *BMJ Open*. 2024

Aug;14(8):e085758. doi:10.1136/bmjopen-2024-085758

31. Campbell O, Graham W. Strategies for reducing maternal mortality: getting on with what works. *The Lancet*. 2006;368(9543):1284–99.
32. Omole VN, Bayero SA, Ibrahim MJ, Usman NO, Audu O, Irohibe KC. Preferences regarding place of delivery among rural and urban women in Kaduna State, Nigeria: a comparative study. *P H Med J*. 2024 Oct 24;18(2):55. doi:10.60787/PHMJ.V18I2.146
33. Johnson O, Obidike P, Eroh M, Okpon A, Bassey E, Patrick P, et al. Choices and determinants of delivery location among mothers attending a primary health facility in Southern Nigeria. *Niger Postgrad Med J*. 2020;27(1):42. doi:10.4103/npmj.npmj_150_19
34. Azuh D, Azuh A, Iweala E, Adeloye D, Akanbi M, Mordi R. Factors influencing maternal mortality among rural communities in southwestern Nigeria. *Int J Womens Health*. 2017;179–88.
35. Bhutta Z, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. *The Lancet*. 2010;375(97730):2032–44.
36. Gabrysch S, Campbell O. Still too far to walk: literature review of the determinants of delivery service use. *BMC Pregnancy Childbirth*. 2009;9(1):34.
37. Dotse-Gborgbortsi W, Dwomoh D, Alegana V, Hill A, Tatem AJ, Wright J. The influence of distance and quality on utilisation of birthing services at health facilities in Eastern Region, Ghana. *BMJ Glob Health*. 2020 Feb;4(Suppl 5):e002020. doi:10.1136/bmjgh-2019-002020

Radiographic Quality Assurance and Patient Radiation Safety: A Repeat and Reject Analysis of Plain Radiographs at a Tertiary Hospital in Kano, Nigeria

Maryjane Chizoba Enyinnaya¹, Mustapha Alhaji Barde^{1*}, Abubakar Shehu Barde¹, Maryam Olaitan¹, Abdulrazaq Zubair², Abbas Rabi Muhammad³

¹Department of Medical Radiography, Faculty of Allied Health Sciences, College of Health Sciences, Bayero University, Kano, Nigeria

²Department of Radiography and Radiation Sciences, Faculty of Allied Health Science, Federal University of Health Sciences, Azare, Nigeria

³Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences, Bayero University, Kano, Nigeria

Corresponding Author: Mustapha Alhaji Barde, Email: mbarde.radg@buk.edu.ng

<https://dx.doi.org/10.4314/yomj.v2i2.7>

Received: 23-Jun-2026

Accepted: 16-Aug-2026

Published: 31-Aug-2026

ABSTRACT

Background: Rejected radiographs necessitate repeat examinations, thereby increasing patient radiation dose, operational costs, waiting times, and occupational exposure for personnel. Film reject analysis (FRA) is an essential quality control tool in conventional medical imaging departments that provides valuable assessment of imaging quality and patient dose.

Methods: A prospective cross-sectional study was conducted over a six-month period at a tertiary hospital. A total of 3,021 plain radiographic films were examined, of which 193 were rejected. Rejected radiographs were collected daily and analysed weekly by senior radiographers using a viewing box. Data on film size, examination type, patient age group, and cause of rejection were recorded on a data capture sheet. Data were analysed and computed.

Results: The overall film reject rate was 6.39% (95% confidence interval: 5.57%–7.32%). The lumbosacral spine radiographs had the highest number of rejected films (n = 38, 19.7%), while the abdominal radiographs had the lowest (n = 1, 0.5%). The commonest causes of rejection were overexposure (n = 57, 29.5%) and underexposure (n = 53, 27.5%). The most frequently rejected film sizes were 35 × 35 cm (n = 69, 35.8%) and 35 × 43 cm (n = 62, 32.1%). Adults accounted for 172 (89.1%) of rejected films, compared with 21 (10.9%) for paediatric patients.

Conclusion: The overall reject rate of 6.39% exceeds the 5% threshold recommended by the World Health Organization. Overexposure and underexposure were the predominant causes of rejection. These findings underscore the need for strengthened quality assurance programs, including technique chart implementation, equipment quality control testing, and regular reject analysis monitoring at the study facility.

Keywords: *Film reject analysis; quality assurance; radiography; repeat rate; patient radiation do*

Cite this article: Enyinnaya MC, Barde MA, Barde AS, Olaitan M, Zubair A, Muhammad AR. Radiographic Quality Assurance and Patient Radiation Safety: A Repeat and Reject Analysis of Plain Radiographs at a Tertiary Hospital in Kano, Nigeria: a case series. Yob Med J.2026;2(2):149-155

Introduction

Every diagnostic radiograph represents a delicate balance between image quality and patient safety.¹ A rejected radiographic image that fails to provide the necessary anatomical information for clinical decision-making triggers a cascade of consequences such as unnecessary radiation exposure, increased departmental costs, prolonged waiting times, and heightened occupational risk for staff.^{2,3} For an image to be considered diagnostic, it must demonstrate the anatomy under examination, include appropriate anatomical markers, and contain accurate patient identifiers and examination dates.⁴ Film reject analysis (FRA) is a structured programme for evaluating rejected radiographs to identify patterns, causes, and trends in image rejection. It serves as a fundamental component of quality assurance (QA) programmes in diagnostic radiology departments.^{3,5} The primary goal of QA in diagnostic imaging is to produce consistently high-quality radiographs with the minimum radiation exposure necessary.⁵ Through systematic reject analysis, departments can identify weaknesses in radiographic technique, equipment performance, and processing protocols, enabling targeted interventions to improve practice.⁶

Despite the global transition toward digital imaging, conventional radiography remains an essential diagnostic modality worldwide, particularly in low- and middle-income countries where they continue to serve as the backbone of basic imaging services.⁷ However, poor-quality radiographs leading to repeat examinations remain a significant concern, increasing costs, radiation exposure, waiting times, and diagnostic delays.² The International Commission on Radiological Protection (ICRP) recommends that medical exposures should be kept as low as reasonably achievable (ALARA), and film reject analysis is a practical approach to achieving this objective.⁸ The Conference of Radiation Control Program Directors

(CRCPD) Committee on Quality Assurance suggests that facilities should strive for a repeat rate not exceeding 5–7%,⁹ while the World Health Organization (WHO) recommends a permissible reject rate of 5%.¹⁰

Despite the established importance of reject analysis, data from sub-Saharan Africa, and particularly from Northern Nigeria, remain limited. This study was therefore conducted to determine the plain radiographic rejection rate and to identify the main causes of rejection according to examination type, film size, and patient age group.

Methodology

This prospective cross-sectional study was conducted at the National Orthopaedic Hospital, Dala, Kano State, Nigeria, over a six-month period from July to September 2019. The hospital is a tertiary specialist orthopaedic facility serving patients from Kano State and surrounding regions. All conventional (analogue) plain radiographic films exposed for diagnostic purposes during the study period were included using a consecutive sampling method, whereby all rejected plain radiographs were collected prospectively. Radiographs of diagnostic quality, digital radiographs, and contrast studies were excluded. Ethical approval for this study was obtained from the Research Ethics Committee of the National Orthopaedic Hospital, Dala (Reference No: NOHD/REC/2019/047), and permission to conduct the research was sought from the hospital management. All rejected radiographs were handled confidentially and stored securely in the hospital archives after analysis.

The instruments for data collection included a structured data capture sheet, a film bin for gathering rejected radiographs, and a viewing box. Rejected radiographs were collected on a daily basis from three conventional diagnostic rooms. Films rejected by attending radiologists or senior radiographers were analysed weekly using a viewing box under standardised room lighting and temperature conditions by two

senior radiographers. The following variables were recorded for each rejected film: radiographic examination type (body part imaged), film size, patient age group (adult or paediatric), and cause of rejection. Causes of rejection were classified into the following categories: overexposure, underexposure, double exposure, positioning error, fog, motion blur, artifact, cut-off, equipment fault, and processing fault. To ensure consistency in the classification of rejection causes, a random sample of 20% of the rejected films was independently reviewed by two senior radiographers. Inter-rater agreement was assessed using Cohen's kappa coefficient ($\kappa = 0.84$), indicating substantial agreement.¹¹ Discrepancies were resolved by consensus discussion before final classification. Data were entered into Microsoft Excel 2007 and analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics, including frequencies and percentages, were computed. The film reject rate was calculated as: (Number of rejected films / Total number of films used) $\times 100$. The 95% confidence interval for the overall reject rate was computed using the Wilson score method.

Results

A total of 3,021 radiographic films were exposed during the study period, of which 193 were rejected. The overall film reject rate was 6.39% (95% confidence interval: 5.57%–7.32%).

Figure 1 shows Adult patients accounted for the majority of rejected radiographs ($n = 172$, 89.1%), while paediatric patients accounted for 21 (10.9%) of rejections.

Distribution of Rejected Radiographs by Age Group (n = 193)

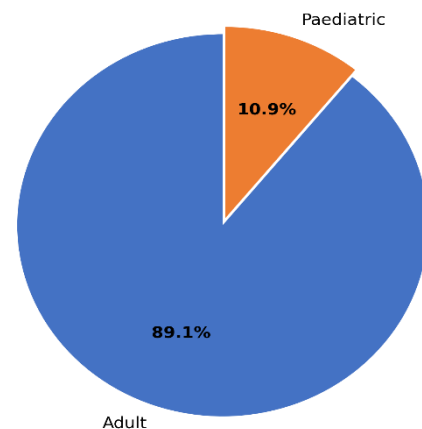


Figure 1. Distribution of rejected radiographs by age group (n = 193)

Table 1 presents the distribution of rejected films according to radiographic examination type. The lumbosacral spine had the highest number of rejected films ($n = 38$, 19.7%), followed by the chest ($n = 27$, 14.0%) and the leg ($n = 22$, 11.4%). The abdomen had the lowest reject rate ($n = 1$, 0.5%).

Examination Type	Frequency (n)	Percentage (%)
Shoulder	6	3.1
Arm	6	3.1
Forearm	2	1.0
Elbow	8	4.1
Hand	2	1.0
Thigh	11	5.7
Knee	18	9.3
Leg	22	11.4
Ankle	2	1.0
Foot	3	1.6
Hip	7	3.6
Pelvis	17	8.8
Abdomen	1	0.5
Cervical spine	11	5.7
Thoracic spine	10	5.2
Lumbar spine	38	19.7
Chest	27	14.0
Skull	6	3.1
Total	193	100.0

Table 1. Distribution of rejected films according to radiographic examination type

Table 2 shows the distribution of rejected films according to the stated cause of rejection. Overexposure was the most common cause ($n = 57$, 29.5%), closely followed by underexposure ($n = 53$,

27.5%). Equipment fault accounted for 21 (10.9%) of rejected films, while fog and cut-off were responsible for 17 (8.8%) and 14 (7.3%) rejections, respectively. Motion blur was the least common cause ($n = 1$, 0.5%).

Cause of Rejection	Frequency (n)	Percentage (%)
Overexposure	57	29.5
Underexposure	53	27.5
Double exposure	3	1.6
Positioning error	3	1.6
Fog	17	8.8
Motion blur	1	0.5
Artifact	10	5.2
Cut-off	14	7.3
Equipment fault	21	10.9
Processing fault	12	6.2
Others	2	1.0
Total	193	100.0

Table 2. Distribution of rejected films according to cause of rejection

Table 3 shows the most frequently rejected film sizes were 35 x 35 cm ($n = 69$, 35.8%) and 35 x 43 cm ($n = 62$, 32.1%), followed by 24 x 30 cm ($n = 30$, 15.5%) and 30 x 40 cm ($n = 29$, 15.0%). The 18 x 24 cm size had the lowest rejection rate ($n = 3$, 1.6%).

Film Size	Frequency (n)	Percentage (%)
18 x 24 cm	3	1.6
24 x 30 cm	30	15.5
30 x 40 cm	29	15.0
35 x 35 cm	69	35.8
35 x 43 cm	62	32.1
Total	193	100.0

Table 3. Distribution of rejected films according to film size

Table 4: compares the overall reject rate from the present study with those reported in previous studies from various countries. The reject rate of 6.38% in the present study falls within the range reported in similar

studies conducted in Nigeria and other developing countries.

Study	Location	Reject Rate (%)
Present study	Kano, Nigeria	6.38
Teferi et al. (2008)	Addis Ababa, Ethiopia	4.94
Jwanbot et al. (2017)	Jos, Nigeria	7.30
Jabbari et al. (2012)	Urmia, Iran	7.20
Benza et al. (2018)	Windhoek, Namibia	8.00
Akintomide et al. (2011)	Calabar, Nigeria	8.86
Joseph et al. (2015)	Bauchi, Nigeria	9.62
Usha et al. (2014)	Delhi, India	22.12
Sadiq et al. (2017)	Maiduguri, Nigeria	29.34

Table 4. Comparison of overall reject rates with previous studies

Discussion

This study assessed the rate and causes of plain radiograph rejection at the National Orthopaedic Hospital, Dala, over a three-month period. The overall reject rate of 6.39% (95% CI: 5.57% - 7.32%) exceeds the 5% threshold recommended by the WHO¹⁰ but falls below the 10% upper limit suggested by the CRCPD Committee on Quality Assurance.⁹ The finding is consistent with previous studies conducted in Nigeria, including reports from Calabar (8.86%)¹², Jos (7.3%)¹³, and Bauchi (9.62%).¹⁴ The lower rates reported in Ethiopia (4.94%)¹⁵ and Ghana (5.6%)² may reflect differences in departmental quality assurance infrastructure, equipment maintenance protocols, or categorisation schemes for causes of rejection.

The reject rate of 6.39% in the present study falls within the range reported in similar studies conducted in Nigeria and other developing countries (table 4), though it remains higher than the WHO benchmark. The wide variation in reported reject rates ranging from 4.94% in Ethiopia to 29.34% in Maiduguri Nigeria, highlights the influence of local contextual factors, including equipment age, maintenance schedules, radiographer training, and the presence of formal QA programmes.³ Notably, the highest reported rates originate from facilities with predominantly conventional radiography systems and limited QC infrastructure, underscoring the vulnerability of analogue imaging to

technique and processing errors. The present study's rate positions the National Orthopaedic Hospital, Dala, within the moderate-risk category, suggesting that while the department does not face a crisis-level rejection burden, systematic quality improvement is warranted to approach the 5% target.

Overexposure (29.5%) and underexposure (27.5%) were the predominant causes of rejection in this study, collectively accounting for 57% of all rejected films. This finding is consistent with previous reports from Bauchi¹⁴, Jos¹³, and Ghana², where exposure errors were similarly identified as the leading causes of rejection. The high prevalence of exposure errors may be attributable to several factors: the absence of standardised exposure technique charts in the study facility, variation in radiographer experience with manual exposure selection, and failure to account for individual patient body habitus when selecting exposure parameters.¹⁶ The lack of a formal quality control programme for X-ray equipment may also contribute to inconsistent output, leading to unpredictable exposure results.

The lumbosacral spine had the highest rejection rate (19.7%), which is consistent with the findings of Akintomide et al.¹² in Calabar, who reported that the lumbosacral spine accounted for the highest proportion of rejected films. The relatively high rejection rate for lumbosacral and chest examinations may reflect the technical challenges associated with imaging thicker body parts, where optimal exposure factor selection is more critical. In contrast, the low rejection rate for abdominal radiography (0.5%) may be due to the limited number of such examinations performed at this orthopaedic-specialist facility.

The predominance of rejections among adult patients (89.1%) compared with paediatric patients (10.9%) is consistent with the study by Alyousef et al.⁴ in Saudi Arabia, where adults accounted for 60% of rejected films. The higher rejection rate

among adults at the present facility is likely attributable to the hospital's specialist orthopaedic focus, which predominantly serves adult patients presenting with musculoskeletal trauma and degenerative conditions. Additionally, the larger body habitus of adult patients presents greater technical challenges in achieving optimal exposure, particularly when technique charts are unavailable.¹⁶

The 35 × 35 cm and 35 × 43 cm film sizes accounted for the majority of rejections (67.9% combined). This is consistent with the findings of Teferi et al.¹⁵ in Ethiopia, who reported that larger film formats had the highest rejection rates. The predominance of these sizes reflects their routine use for examinations of the spine, chest, and pelvis, which together constitute a substantial proportion of the workload at an orthopaedic hospital.

The findings of this study have important implications for radiation protection practice. A reject rate above the WHO-recommended threshold indicates that a notable proportion of patients at this facility are receiving unnecessary additional radiation exposure from repeat examinations. Implementation of systematic quality assurance measures, including the introduction of exposure technique charts, regular equipment quality control testing, and periodic reject analysis monitoring, would be expected to reduce the reject rate and optimise patient doses in line with the ALARA principle.^{3,9}

Conclusion

Conventional radiography remains indispensable in many clinical settings, yet its clinical value is contingent upon disciplined quality assurance. This study establishes a local baseline for image rejection at a tertiary orthopaedic facility in Northern Nigeria, highlighting systemic opportunities for dose optimisation and practice improvement. Rather than viewing reject analysis as an isolated audit, departments should integrate it into a continuous quality cycle one that links equipment performance, technique

standardisation, and staff competency directly to patient safety outcomes. Institutionalising these measures will align local practice with international radiation protection standards while enhancing diagnostic throughput and resource stewardship. The framework proposed here offers a replicable model for similar facilities seeking to transition from reactive error correction to proactive quality governance.

Limitations

The study was conducted at a single specialist orthopaedic hospital, limiting the generalisability of findings to general hospitals or other healthcare settings. Second, the study did not quantify the economic costs associated with rejected films or the additional radiation doses received by patients from repeat examinations.

Recommendations

Based on the findings of this study, it is recommend that the department should establish a formal Quality Assurance Committee with responsibility for planning, monitoring, and evaluating quality improvement initiatives. In addition, standardised exposure technique charts should be developed and made available in each diagnostic room, tailored to specific body parts and patient body habitus.

Conflict of Interest The authors declare that they have no conflicting interests.

Funding This research received no external funding.

References

1. Benza C, Damases C, Amkongo M, et al. The causes of reject images in a radiology department at a state hospital in Windhoek, Namibia. *South African Radiographer*. 2018;56(1):5-9.
2. Owusu-Banahene J, Darko EO, Hasford F, Addison EK, Asirifi JO. Film reject analysis and image quality in diagnostic radiology department of a teaching hospital in Ghana. *J Radiat Res Appl Sci*. 2014;7(4):589-594. doi:10.1016/j.jrras.2014.09.012
3. Royal College of Radiologists. Image rejection analysis in digital radiography. London: RCR; 2024.
4. Alyousef KA, Alkahtani S, Alessa R, Alruweili H. Radiographs reject analysis in a large tertiary care hospital in Riyadh. *Glob J Qual Saf Healthc*. 2019;2(2):30-33. doi:10.4103/JQSH.JQSH_24_18
5. Alahmadi O, Alrehaili A, Gameraddin M. Evaluation of reject analysis of chest radiographs in diagnostic radiology. *Am J Diagn Imaging*. 2019;5(1):4-8. doi:10.5455/ajdi.20180830110208
6. Sadiq AA, Miftaudeen MN, Mohammed A, et al. Reject-repeat analysis of plain radiographs as a quality indicator at University of Maiduguri Teaching Hospital. *Eur J Pharm Med Res*. 2017;4(2):188-191.
7. Usha M, Bhargava S, Bhatt S. Reject analysis in conventional radiography. *Nepalese J Radiol*. 2014;4(2):32-38. doi:10.3126/njr.v4i2.9612
8. International Commission on Radiological Protection. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann ICRP. 2007;37(2-4):1-332.
9. Conference of Radiation Control Program Directors. Quality control recommendations for diagnostic radiography. Vol. 1. Frankfort, KY: CRCPD; 2008.
10. World Health Organization. Quality Assurance in Diagnostic Radiology. Geneva: WHO; 1988.
11. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-174.

12. Akintomide AO, Egbe NO, Bassey DE, Eduwem DU, Oyama EA. An analysis of repeated examinations in conventional film-screen radiography. *J Assoc Radiogr Niger*. 2011;25(1):14-20.
13. Jwanbot DI, Sirisena UAI, Akpolile FD, Tungtur TS, Nkop PM. Analysis of reject radiographic films as a quality assurance element in diagnostic radiology. *Int J Innov Healthc Res*. 2017;5(1):24-30.
14. Joseph DZ, Mohammed S, Samuel S, Abubakar M, Goni M, Itopa R. Film reject analysis in radiology department of a teaching hospital in north-eastern Nigeria. *Niger J Med Imaging Radiat Ther*. 2015;4(1):21-27.
15. Teferi S, Admassie D, Zewdenesh D. X-ray film reject rate analysis at eight selected government hospitals in Addis Ababa, Ethiopia. *Ethiop J Health Dev*. 2008;22(1):63-67.
16. Bunsen J, Fawcett T, McNulty J, et al. Patient-based radiographic exposure factor selection: a systematic review. *Radiography*. 2014;20(4):318-324. doi:10.1016/j.radi.2014.03.003
17. Al-Mohammed AA, Al-Dhahiyani SM, Al-Mousa DS, et al. An assessment of image reject rates for digital radiography in Saudi Arabia: A cross-sectional study. *J Radiat Res Appl Sci*. 2022;15(4):100608. doi:10.1016/j.jrras.2022.100608
18. Tzeng YF, Stephenson-Smith A, et al. Digital radiography reject analysis of examinations with multiple rejects: an Australian emergency imaging department clinical audit. *J Med Radiat Sci*. 2021;68(2):142-149. doi:10.1002/jmrs.468

Pneumococcal vaccine awareness, acceptance, and hesitancy among caregivers of children with sickle cell anaemia attending a tertiary hospital in north-eastern NigeriaAyuba Zakar¹, Falmata Mustapha Grema², Tsuung Ason Benjamin³¹Department of Haematology and Blood Transfusion, Yobe State University Damaturu-Nigeria²Department of Haematology and Blood Transfusion, Abubakar Tafawa Balewa University Bauchi, Nigeria³Department of Family Medicine, Yobe State University Damaturu-Nigeria**Corresponding author: Ayuba Zakar, Email: ayubanet@yahoo.com**<https://dx.doi.org/10.4314/yomj.v2i2.8>**Received: 03-Jun-2026****Accepted: 18-Aug-2026****Published: 31-Aug-2026****ABSTRACT**

Background: Children with sickle cell anaemia (SCA) are at increased risk of invasive pneumococcal disease (IPD) due to functional asplenia and impaired immunity. Although the pneumococcal vaccine (PCV) effectively prevents IPD, caregivers' awareness, acceptance, and hesitancy strongly influence vaccine uptake.

Methods: We conducted a cross-sectional study among caregivers of children with SCA who attended the Yobe State Specialist Hospital in Potiskum from April to June 2026. We collected data using interviewer-administered questionnaires and analysed them using descriptive and inferential statistics. We assessed associations between categorical variables using Chi-square and Fisher's exact tests, with significance set at $p < 0.05$.

Results: Of the 126 caregivers who participated in the study, 88.9% had heard of PCV, with healthcare workers as the primary source of information (82.5%). Furthermore, 72.2% correctly identified the disease prevented by PCV, and 73.0% knew it is recommended for children with SCA; 85.7% of children had received the vaccine, with 76.2% completion of the recommended doses. Vaccine acceptance was largely driven by protection from severe illness (58.3%) and healthcare provider recommendations (25.0%). Conversely, fear of side effects (27.8%) and vaccine unavailability (27.8%) were the main reasons for hesitancy. Information source was significantly associated with vaccine uptake ($\chi^2 = 49.723$, $p < 0.001$).

Conclusion: Caregivers showed high PCV awareness and acceptance, with healthcare providers as the primary information source. Addressing vaccine safety concerns, improving availability, and strengthening caregiver education may further reduce hesitancy and improve uptake among children with SCA.

Keywords: Sickle Cell Anaemia; Pneumococcal vaccine; Vaccine awareness; Vaccine acceptance; Vaccine hesitancy; North-Eastern Nigeria

Cite this article: Zakar A, Grema FM, Benjamin TA. Pneumococcal vaccine awareness, acceptance, and hesitancy among caregivers of children with sickle cell anaemia attending a tertiary hospital in north-eastern Nigeria. Yob Med J.2026;2(2):156-166

INTRODUCTION

Sickle Cell Anaemia (SCA) is the homozygous inheritance of the haemoglobin S gene. In its classical form, the disease is characterised by chronic haemolysis, episodic bone pain, chronic organ deterioration, and an overall reduction in quality of life [1]. A painful episode, the so-called vaso-occlusive crisis, occurs when sickled red cells obstruct blood flow, leading to tissue ischaemia. Repeated vaso-occlusion of the splenic vessels may lead to splenic infarction, reducing the spleen's size and function. In extreme cases, the spleen may be undetectable on ultrasonography, a condition known as auto-splenectomy [2]. Functional asplenia refers to the global impairment of splenic function, predisposing SCA patients to infection with encapsulated organisms such as *Neisseria meningitidis*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Salmonella* [3].

According to the World Health Organisation, pneumonia accounted for 14% of all deaths among children under 5 years, killing about 740,180 children in 2019 [4]. Standard protocols for preventing *S. pneumoniae* infection in children with SCA include oral penicillin V prophylaxis for the first 5 years and vaccination [5]. The conjugate pneumococcal vaccine (PCV) reduced the incidence of invasive pneumococcal disease (IPD) by 90.8% in children < 2 years and by 93.4% in those > 5 years [6]. A crude analysis estimated the effectiveness of a single dose of PCV at 84.5% among Sickle Cell Disease (SCD) patients aged <10 years [7]. Nigeria, through the Global Vaccine Initiative (GAVI), introduced the 10-valent PCV in 2014 as part of the routine childhood immunisation schedule, administered at 6, 10, and 14 weeks, expected to save 35,000 infant lives annually [8].

Although advances in preventive care have improved health outcomes in high-income countries, children with SCA in middle- and low-income countries (LMICs) still experience preventable complications due to delayed diagnosis, limited access to comprehensive care, and suboptimal vaccine uptake. Vaccine hesitancy has emerged as a major threat to immunisation programs in LMICs, and the WHO has identified it as one of the top ten threats to global health [9,10]. However, vaccine hesitancy is a complex, multifactorial phenomenon

influenced by cultural and religious beliefs, socioeconomic factors, confidence in the health system and providers, and misinformation. In LMICs, these challenges are compounded by vaccine stock-outs, poor transportation networks, and inadequate health education [11,12].

About 150,000 babies are born with SCD annually in Nigeria [13]. These children are at risk of IPD, making accelerated vaccine coverage a strategic necessity, especially in North-Eastern Nigeria, which sits at the intersection of a high SCA burden, historical vaccine distrust, and low education. Despite the well-established benefits of PCV, evidence on caregivers' awareness, acceptance, and hesitancy toward pneumococcal vaccination for children with SCA remains limited in Nigeria, especially in the North-East. Understanding caregivers' knowledge, attitudes, and vaccine-related concerns is essential to identify barriers to PCV uptake and inform targeted interventions to improve coverage among this high-risk population. Our study therefore aimed to assess awareness, acceptance, and hesitancy among caregivers of children with SCA attending a tertiary health facility in North-Eastern Nigeria, providing practical insight into barriers to vaccine uptake and suggesting ways to overcome them. It will also contribute to the limited body of literature on PCV uptake in North-Eastern Nigeria.

METHODOLOGY

1. Study design and setting.

This hospital-based, descriptive, cross-sectional study was conducted among caregivers of children with SCA who attended the Sickle Cell Clinic of the Yobe State Specialist Hospital, Potiskum (YSSHP), a 300-bed tertiary health facility, from April to June 2026. Potiskum is the commercial centre of Yobe State in North-Eastern Nigeria. Yobe has one of the highest burdens of SCD in Nigeria. The clinic provides comprehensive care for patients with SCA, including routine follow-up, immunisation counselling, and treatment of acute and chronic complications.

2. Ethical Considerations

Ethical approval was obtained from the Ethics and Research Committee of the Yobe State Ministry of Health (REF: YB/HREC/APRIL/26/010). The study followed the principles of the Declaration of Helsinki

governing research involving human subjects. We obtained written informed consent from participating caregivers after explaining the study objectives, procedures, and expected benefits for children with SCA. Participation was voluntary, and caregivers were informed of their right to withdraw at any time without affecting the health services provided to their patients. We maintained confidentiality by anonymising the questionnaires.

3. Study population

The study population comprised caregivers of children with SCA aged 0-18 years who attended the Sick Cell clinic at YSSHP during the study period. Caregivers were parents, guardians, or adult family members responsible for the child's health needs for at least 6 months prior to the study.

4. Data Collection

Data were collected using questionnaires covering caregivers' socio-demographic characteristics and those of their children, as well as awareness of PCV, acceptance and hesitancy. It also examined factors influencing awareness, acceptance and hesitancy, including accessibility, cost, healthcare provider recommendations, and perceived vaccine safety. Researchers and their trained assistants collected data. Interviews were conducted in English or Hausa, depending on the respondent's preference.

5. Statistical analysis

Data were entered into Microsoft Excel, cleaned, and exported to the Statistical Package for the Social Sciences (SPSS) version 22 (IBM Corp., Armonk, NY, USA) for analysis. We summarised categorical variables using frequencies and percentages. We described awareness, acceptance, and hesitancy towards pneumococcal vaccination using proportions with corresponding 95% confidence intervals where appropriate. We assessed associations between caregiver characteristics and awareness, acceptance, or hesitancy using the Chi-square test and Fisher's exact test. Results were presented in tables and charts. Statistical significance was set at a two-tailed p-value of less than 0.05 ($p < 0.05$).

RESULTS

Table 1: Socio-demographic Characteristics of the Caregivers of Children with SCA attending the sickle cell clinic of YSSHP from April to June 2026 (n=126).

Socio-demographic Characteristics	Frequency	Percent
Age (years)		
≤5	53	42.1
6-11	36	28.6
12-17	31	24.6
18	6	4.8
Sex		
Male	46	36.5
Female	80	63.5
Age of caregiver (years)		
<20	2	1.6
20-29	19	15.1
30-39	37	29.4
40-49	50	39.7
>50	18	14.3
Sex of caregiver		
Male	22	17.5
Female	104	82.5
Relationship with patient		
Mother	95	75.4
Father	18	14.3
Guardian	12	9.5
Sister	1	.8
Marital status		
Single	4	3.2
Married	116	92.1
Widowed	3	2.4
Divorced/Separated	3	2.4
Educational level		
No formal education	48	38.1
Primary	18	14.3
Secondary	28	22.2
Tertiary	32	25.4
Occupation		
Business	24	19.0

Civil servant	16	12.7
Driver	2	1.6
Farmer	6	4.8
Housewife	68	54.0
Retired civil servant	1	.8
Self-employed	2	1.6
Student	3	2.4
Teacher	3	2.4
Trader	1	.8

No of Children in the family

1-5	58	46.0
6-10	55	43.7
11-15	13	10.3

No. of children with SCA

1	68	54.0
2	40	31.7
3	11	8.7
4	7	5.6

Income (₦)

<50,000	71	56.3
50,000-100,000	41	32.5
101,000-200,000	14	11.1

*SCA: Sickle Cell Anaemia***Table 2: Awareness of Pneumococcal Vaccine among the Caregivers of Children with SCA (n= 126)**

Awareness of Pneumococcal Vaccine	Frequency	Percent
Heard of the pneumococcal vaccine before		
Yes	112	88.9
No	14	11.1
Source of Information		
Health worker	104	82.5
Media (TV/Radio/social media)	6	4.8
Family/friends	2	1.6
Nil	14	11.1

Knew what the pneumococcal vaccine prevents

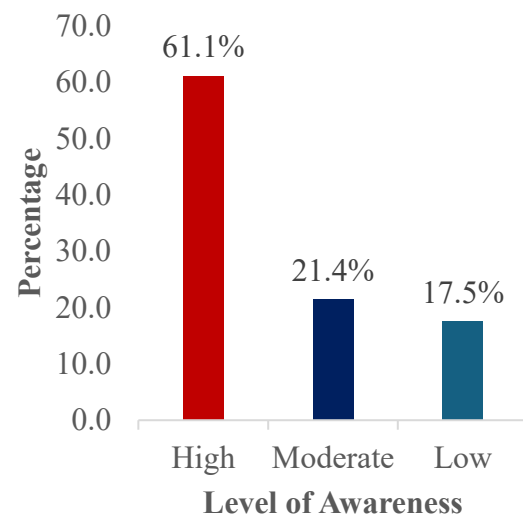
Yes	91	72.2
No	18	14.3
Not Sure	17	13.5

Aware of high-risk infection in children with SCA

Yes	91	72.2
No	35	27.8

Aware of pneumococcal vaccine recommended for SCA patients

Yes	92	73.0
No	34	27.0

SCA: Sickle Cell Anaemia**Figure 1: Level of Awareness of Pneumococcal Vaccine among the Caregivers of Children with SCA (n=126).****Table 3: Acceptance of Pneumococcal Vaccine among Caregivers of Children with SCA (n=126)**

Acceptance of Pneumococcal Vaccine	Frequency	Percent
The child/ward was vaccinated		
Yes	108	85.7
No	11	8.7
Not sure	7	5.6
Doses administered to the child/ward		
1 Dose	3	2.4
2 Doses	9	7.1
Full recommended doses	96	76.2
Not sure	7	5.6
None	11	8.7

SCA: Sickle Cell Anaemia

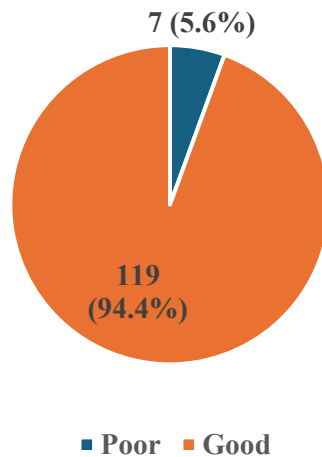


Figure 2: Level of Acceptance of Pneumococcal Vaccine among Caregivers of Children with SCA (n=126)

Table 4: Reasons for Hesitancy Towards Pneumococcal Vaccine among Caregivers of Children with SCA

Hesitancy towards pneumococcal vaccine	Frequency	Percent
Reason for being hesitant or not vaccinating your child/ward (n=18)		
Lack of Awareness	2	11.1
High cost of vaccine	2	11.1
Fear of side effects	5	27.8
Lack of trust in vaccines	3	16.7
Vaccine not available	5	27.8
Religious or Cultural reasons	1	5.6

Encouragement from health workers will motivate me to vaccinate my child/ward (n=18)

Yes	15	83.3
Not sure	3	16.7

Believe in vaccine safety for children (n=126)

Yes	116	92.1
No	2	1.6
Not sure	8	6.3

Vaccines should be free for SCA patients (n=126)

Yes	114	90.5
No	12	9.5

Ways to improve pneumococcal vaccine uptake for SCA patients (n=126)

Government Should Create more Awareness	72	57.1
Government Should Provide free vaccines	3	2.4
Government Should Improve the vaccine	4	3.2
No response	47	37.3

SCA: Sickle Cell Anaemia

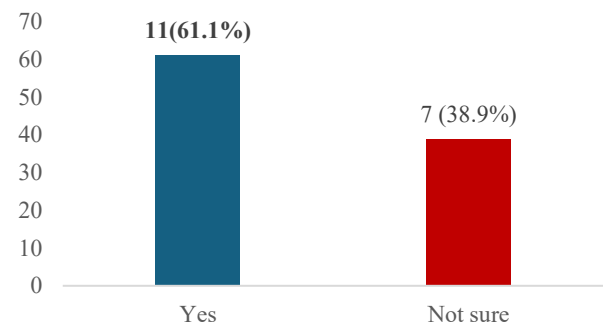


Figure 3: Assessment of Willingness to Take Up Vaccination among Caregivers of Unvaccinated Children/Ward (n=18)

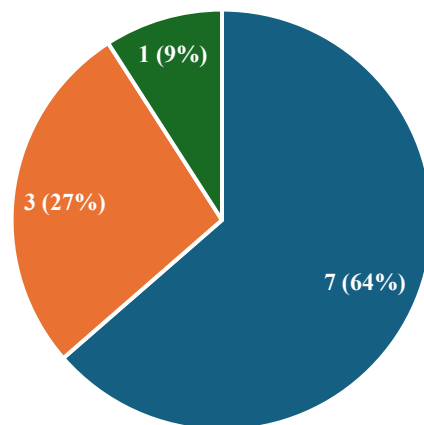


Figure 4: Motivation if willing to allow child/ward to be vaccinated (n=11).

Table 5: Association Between Socio-demographic Characteristics and Acceptance of Pneumococcal Vaccination among Caregivers of Children with SCA Not Vaccinated (n=18)

Socio-demographic Characteristics	Acceptance of Pneumococcal Vaccine			Test Statistics	Df	p-value	Tertiary value
	Good	Poor	Total				
Age (years)							
≤5	5 (27.8%)	1 (5.5%)	6 (33.3%)	F.E = - 4.530	-	0.814	
6-11	4 (22.2%)	3 (16.7%)	7 (38.9%)				
12-17	3 (16.7%)	0 (0.0%)	3 (16.7%)				
18	2 (11.1%)	0 (0.0%)	2 (11.1%)				
Sex							
Male	8 (44.4%)	2 (11.1%)	10 (55.6%)	X ² = 1 0.524	1	0.807	
Female	6 (33.3%)	2 (11.1%)	8 (44.4%)				
Age of caregiver (years)							
<20	0 (0.0%)	0 (0.0%)	0 (0.0%)	F.E = - 11.399	-	0.137	
20-29	5 (27.8%)	1 (5.5%)	6 (33.3%)				
30-39	5 (27.8%)	1 (5.5%)	6 (33.3%)				
40-49	3 (16.7%)	1 (5.5%)	4 (22.2%)				
>50	1 (5.5%)	1 (5.5%)	2 (11.1%)				
Sex of caregiver							
Male	3 (16.7%)	2 (11.1%)	5 (27.8%)	X ² = 1 0.272	1	0.873	
Female	11 (61.1%)	2 (11.1%)	13 (72.2%)				
Relationship with patient							
Mother	9 (50.0%)	2 (11.1%)	11 (61.1%)	F.E = - 11.451	-	0.045	
Father	2 (11.1%)	1 (5.5%)	3 (16.7%)				
Guardian	2 (11.1%)	1 (5.5%)	3 (16.7%)				
Sister	1 (5.5%)	0 (0.0%)	1 (5.5%)				
Marital status							
Single	1 (5.5%)	0 (0.0%)	1 (5.5%)	F.E = - 14.488	-	0.007	
Married	12 (66.7%)	4 (22.2%)	16 (88.9%)				
Widowed	0 (0.0%)	0 (0.0%)	0 (0.0%)				
Divorced/Separated	1 (5.5%)	0 (0.0%)	1 (5.5%)				
Educational level							
No formal education	4 (22.2%)	1 (5.5%)	5 (27.8%)	X ² = 3 15.416	3	0.016	
Primary	2 (11.1%)	1 (5.5%)	3 (16.7%)				
Secondary	4 (22.2%)	1 (5.5%)	5 (27.8%)				
Tertiary	4 (22.2%)	1 (5.5%)	5 (27.8%)				
Occupation							
Business	3 (16.7%)	1 (5.5%)	4 (22.2%)	F.E = - 35.396	-	0.001	
Civil servant	1 (5.5%)	1 (5.5%)	2 (11.1%)				
Driver	0 (0.0%)	0 (0.0%)	0 (0.0%)				
Farmer	1 (5.5%)	0 (0.0%)	1 (5.5%)				
Housewife	7 (38.9%)	2 (11.1%)	9 (50.0%)				
Retired civil servant	0 (0.0%)	0 (0.0%)	0 (0.0%)				
Self-employed	1 (5.5%)	0 (0.0%)	1 (5.5%)				
Student	1 (5.5%)	0 (0.0%)	1 (5.5%)				
Teacher	0 (0.0%)	0 (0.0%)	0 (0.0%)				
Trader	0 (0.0%)	0 (0.0%)	0 (0.0%)				
No. of children in the family							
1-5	7 (38.9%)	2 (11.1%)	9 (50.0%)	F.E = - 18.081	-	0.023	
6-10	6 (33.3%)	1 (5.5%)	7 (38.9%)				
11-15	1 (5.5%)	1 (5.5%)	2 (11.1%)				
No. of children with SCA							
1	7 (38.9%)	2 (11.1%)	9 (50.0%)	F.E = - 18.081	-	0.023	

2	5 (27.8%)	1 (5.5%)	6 (33.3%)	
3	2 (11.1%)	1 (5.5%)	3 (16.7%)	
4	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Income (₦)				
<50,000	7 (38.9%)	2 (11.1%)	9 (50.0%)	$\chi^2 = 20.629$
50,000-100,000	5 (27.8%)	1 (5.5%)	6 (33.3%)	10.620
101,000-200,000	2 (11.1%)	1 (5.5%)	3 (16.7%)	

SCA: Sickle Cell Anaemia; χ^2 : Chi-square; F.E: Fisher's Exact Test; df: degree of freedom; $p \leq 0.05$ is considered statistically significant

Table 6: Association Between Source of Information and Pneumococcal Vaccine Uptake Among Caregivers of Children with SCA (n=126)

Source of Information	The child/ward was vaccinated		Not sure	Total
	Yes	No		
Health worker	98 (77.8%)	4 (3.2%)	2 (1.6%)	104 (82.5%)
Media (TV/Radio/social media)	5 (4.0%)	0 (0.0%)	1 (0.8%)	6 (4.8%)
Family/friends	1 (0.8%)	1 (0.8%)	0 (0.0%)	2 (1.6%)
Nil	4 (3.2%)	6 (4.8%)	4 (3.2%)	14 (11.1%)

$\chi^2 = 49.723$; $df = 3$; $p\text{-value} < 0.001$

χ^2 : Chi-square; df: degree of freedom; $p \leq 0.05$ is considered statistically significant

DISCUSSION

Our study provides the first localised insight into PCV awareness, acceptance, and hesitancy among caregivers of children with SCA in a tertiary health setting in North-Eastern Nigeria. In a resource-limited health system weakened by almost a decade and a half of insurgency, optimising vaccine coverage is cost-effective and strategically necessary to protect highly susceptible populations against vaccine-preventable infections. While our study found a high level of awareness and acceptance of the

PCV, residual gaps remain that must be addressed to ensure comprehensive protection of all children with SCA against IPD.

Most (82.5%) caregivers of children with SCA in this study were female, with the highest proportion (75.4%) being the children's biological mothers. This finding reflects traditional practices in Africa, where women care for children and manage the household, while men seek jobs to bring income to the family. The role of men is necessary, as most of the household's income in this study is below 50,000 naira (<36\$) per month or <1.2\$ per day, a figure grossly insufficient to care for patients with chronic conditions such as SCA. This aligns with the Nigerian Economic Summit Group 2021 report, which revealed that 63% of Nigerians are multidimensionally poor, with the North-East disproportionately affected [14]. Our study further demonstrates the extent of women's educational and economic disempowerment in our society, as evidenced by the high number of women without formal education who were housewives, which suggests unemployment. This calls for urgent policy intervention to address this gender inequality in our setting.

Regarding PCV awareness among respondents, the majority (88.9%) were aware of the vaccine, and 72.9% knew what PCV prevents. Most caregivers (61.1%) demonstrated a high level of awareness. This contrasts with findings from Ghana, where only 4% of caregivers had heard of PCV, and with a study in Benin City, Nigeria, where only 32.3% knew what the vaccine prevents and only 20% demonstrated overall knowledge [15,16]. In the Ghanaian study, caregivers preferred vaccines to tablets, indicating a strong willingness to vaccinate despite poor baseline knowledge. Together, these studies strongly suggest that barriers to PCV uptake are not outright refusal but inadequate caregiver education, suboptimal provider counselling, and low awareness of pneumococcal disease prevention. The primary source of PCV awareness for most caregivers in our study was healthcare workers. The high level of awareness among predominantly uneducated caregivers highlights the important role healthcare workers play in promoting vaccine uptake. Social and

electronic media did not play a significant role in raising PCV awareness among our respondents. The lack of formal education among most caregivers may have limited their participation in and understanding of social and electronic media content. However, this residual gap can be bridged by engaging with healthcare workers to discuss vaccines and their benefits in the dialect most widely understood by the population, via radio, television, and social media.

Our study demonstrated a high level of acceptance of PCV by the caregivers, where the majority (85.7%) of them have vaccinated their children, with 72.6% of them achieving full-dose vaccination of their children. The primary motivation for acceptance is protecting their children from severe illness, followed by the doctor's recommendation. Among caregivers who did not vaccinate their children, acceptance of PCV was associated with several socio-demographic factors, including the caregiver's relationship with the patient, marital status, educational level, occupation, number of children in the family, number of children with SCA, and monthly income ($p < 0.05$).

The significant association between the caregiver's relationship with the patient and acceptance of the PCV may reflect involvement in decision-making about the child's health needs, with the patient's biological parents having greater freedom to decide whether to vaccinate their child than extended family members. This finding underscores the need for targeted vaccine education to all caregivers, especially those responsible for healthcare decision-making.

Marital status showed a statistically significant association with vaccine acceptance. Married caregivers may benefit from more emotional, financial, and social support, which can positively influence the family's joint healthcare decision-making process and compliance with vaccine schedules. Studies have demonstrated that household stability and spousal support positively influence vaccine uptake in children [17,18]. Caregivers who are divorced, widowed, or single may be deprived of the expected spousal support, and if faced with additional financial

pressures, can negatively impact timely vaccine uptake.

Educational attainment was an important determinant of vaccine acceptance by caregivers. Those with higher education are more likely to appreciate the susceptibility of SCA children to IPD, the benefit PCV offers, and are best placed to counter vaccine misinformation. The relationship between education and vaccine acceptance has not always been uniformly positive [19]. Therefore, tailoring information for caregivers with no formal education will help bridge the remaining gap in vaccine acceptance.

Caregivers' occupation and monthly income play important roles in PCV acceptance. Caregivers with better jobs and higher incomes can cover transport costs to immunisation clinics and other immunisation-related expenses. Those with unstable jobs and low household incomes face financial pressure to meet competing household demands, diverting caregivers' attention from their children's health needs, even when they understand the benefits of vaccination. These findings support calls to make vaccines more accessible and fully integrate them into the routine care of SCA patients.

Family size and the number of children with SCA were also significantly associated with PCV acceptance. On the one hand, a large family size may increase competition for available resources among several family members, which may limit the caregiver's ability to access preventive services consistently. On the other hand, an increased number of children with SCA in the family can increase the number of contacts with healthcare providers who can provide them with the right information on vaccines. Also, previous complications in other SCA family members place caregivers in a position to make informed choices about vaccines.

Reasons for vaccine hesitancy among caregivers who did not vaccinate their children include fear of side effects, vaccine unavailability, and lack of trust in vaccines. Only 5.6% of caregivers cited cultural and religious barriers. This contrasts with the past, when cultural and religious barriers were major impediments to vaccine uptake in northern

Nigeria, allowing vaccine-preventable diseases such as poliomyelitis to spread in the region [20]. Lack of trust in the vaccine was cited by 16.7% of hesitant caregivers, suggesting residual mistrust in this region of Nigeria. It is encouraging that most hesitant caregivers believe encouragement from healthcare workers will motivate them to vaccinate their children. This again highlights the critical role healthcare workers can play in eliminating residual barriers to accelerated vaccine coverage.

CONCLUSION

While PCV awareness is high among caregivers of children with SCA in North-Eastern Nigeria, our findings demonstrate that acceptance is heavily dependent on socioeconomic factors and healthcare provider communication. Bridging the gap between awareness and actual vaccine uptake requires a multifaceted approach that addresses socioeconomic factors and health provider-caregiver communication. Implementing these strategies is essential to improve vaccination rates and reduce the burden of IPD among children with SCA.

LIMITATIONS

This single tertiary hospital-based study may have limited generalisability, as respondents likely had greater exposure to health education and healthcare specialists than those attending primary or secondary care, where more children with SCA are found. Therefore, our findings cannot be generalised to caregivers of SCA in North-Eastern Nigeria. In addition, we assessed vaccination status through caregiver self-reports rather than immunisation records. This inability to independently verify vaccination status may have resulted in misclassification of vaccine uptake.

ACKNOWLEDGEMENT

We thank Mr Jamiu Bello for assistance with data analysis.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Yogen S., Elliot YV. Sick Cell Disease: Clinical features and Management. In: Hoffman R, Benz EJ, Silberstein LE, Heslop HE, Weitz JI, Anastasi J, Salama ME, Abutalib SA (eds), Hematology: Basic Principles and Practice 7th edition. Philadelphia: Elsevier, 2018, 585-607.
2. Al-Salem, Ahmed H. Splenic Complications of Sick Cell Anemia and the Role of Splenectomy. International Scholarly Research Notices. 2011; **864257**: 2011-18. <https://doi.org/10.5402/2011/864257>
3. Kirkineska L, Perifanis V, Vasiliadis T. Functional hyposplenism. *Hippokratia*. 2014; **18**:7-11. PMID: 25125944; PMCID: PMC4103047
4. World Health Organization. Pneumonia in children. Available from: <https://www.who.int/news-room/fact-sheets/detail/pneumonia>. Accessed 4th April 2026.
5. Navalkele P, Özgönenel B, McGrath E, et al. Invasive pneumococcal disease in patients with sickle cell disease. *J Pediatr Hematol Oncol*. 2017; **39**:341-4. <https://doi.org/10.1097/MPH.0000000000000858>.
6. Halasa NB, Shankar SM, Talbot TR, et al. Incidence of invasive pneumococcal disease among individuals with sickle cell disease before and after the introduction of the pneumococcal conjugate vaccine. *Clin Infect Dis*. 2007; **44**:1428-33. <https://doi.org/10.1086/516781>
7. Adamkiewicz TV, Silk BJ, Howgate J, et al. Effectiveness of the 7-valent pneumococcal conjugate vaccine in children with sickle cell disease in the first decade of life. *Pediatrics*. 2008; **121**:562-9. <https://doi.org/10.1542/peds.2007-0018>.
8. Adamu AL, Ojal J, Abubakar IA, et al. The impact of introduction of the 10-valent pneumococcal conjugate vaccine

- on pneumococcal carriage in Nigeria. *Nature Communications*. 2023; **14**:2666. <https://doi.org/10.1038/s41467-023-38277-z>
9. Cooper S, Betsch C, Sambala EZ, et al. Vaccine hesitancy—a potential threat to the achievements of vaccination programmes in Africa. *Hum Vaccin Immunother*. 2018; **14**:2355–7. <https://doi.org/10.1080/21645515.2018.1460987>
 10. World Health Organization. Ten threats to global health in 2019 [Internet]. Geneva: WHO; 2019 [cited 2026 Jul 14]. Available from: <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>
 11. Simas, C., Larson, H.J. Overcoming vaccine hesitancy in low-income and middle-income regions. *Nat Rev Dis Primers*. 2021; **7**:41. <https://doi.org/10.1038/s41572-021-00279-w>
 12. Vaccine Hesitancy in Low- and Middle-Income Countries: Determinants and Interventions. *ROJPHM*. 2026; **6**:107–113. <https://doi.org/10.59298/ROJPHM/2026/61107113>
 13. Fraiwan A, Hasan MN, An R, et al. Advancing healthcare outcomes for sickle cell disease in Nigeria using mobile health tools. *Blood*. 2019; **134**:2173. <https://doi.org/10.1182/blood-2019-131344>
 14. Nigerian Economic Summit Group. NESG 2021 Multidimensional Poverty Alert [Internet]. Lagos: NESG; 2022 Nov 20 [cited 2026 Jul 11]. Available from: <https://www.nesgroup.org/research/publication/nescg-2021-multidimensional-poverty-alert--november-2022>
 15. Doe E, Nguah SB, Mensah KB, et al. Caregivers' knowledge, attitude, and perception toward pneumococcal infection prophylaxis in pediatric sickle cell disease patients in Kumasi, Ghana. *Health Sci Rep*. 2023; **6**:e1665. <https://doi.org/10.1002/hsr2.1665>
 16. Ezeuko LC, Odunvbun ME. Special vaccine uptake among children with sickle cell disease: coverage, determinants and barriers in a tertiary hospital in Benin City, Nigeria. *Egyptian Pediatric Association Gaz*. 2026; **74**:51. <https://doi.org/10.1186/s43054-026-00547-y>
 17. Wachinger J, Reñosa MDC, Endoma V, et al. Bargaining and gendered authority: a framework to understand household decision-making about childhood vaccines in the Philippines. *BMJ Global Health*. 2022; **7**:e009781. <https://doi.org/10.1136/bmjgh-2022-009781>
 18. Efendi D, Gayatri N, Kurniawati N, et al. Husband's support synergistically with distance to vaccination centre associated with compliance of childhood vaccination during the COVID-19 pandemic in Indonesia. *Enferm Glob*. 2023; **22**:402–430. <https://doi.org/10.6018/enferm.553931>
 19. Trepanowski R, Drażkowski D. The vaccine-Education paradox in a cross-Country analysis: education predicts higher and lower vaccination rates. *Sage Open*. 2024; **14**: 21582440241253326. <https://doi.org/10.1177/21582440241253326>
 20. Ghinai I, Willott C, Dadari I, et al. Listening to the rumours: what the northern Nigeria polio vaccine boycott can tell us ten years on. *Glob Public Health*. 2013; **8**:1138–50. <https://doi.org/10.1080/17441692.2013.859720>

Arrow-shot injuries following herder–farmer clashes in Gombe, Nigeria: A case series

Nuhu Mshelia Musa¹, Arogundade Abayomi², Ndenwaneku Samuel Okuwa¹, Ogbeide James¹, Suhnun Adamu Bajoga¹, Gabriel Idowu Ajiboye³.

¹General Surgery Unit, Department of Surgery, Federal Teaching Hospital, Gombe.

²Urology Unit, Department of Surgery, Federal Teaching Hospital Gombe.

³Orthopaedic and Trauma Unit, Department of Surgery, State Specialist Hospital, Gombe.

Corresponding author: Dr Ndenwaneku S.O, Email: sndenwaneku@gmail.com

<https://dx.doi.org/10.4314/yomj.v2i2.9>

Received: 13-Jun-2026

Accepted: 02-Aug-2026

Published: 31-Aug-2026

Abstract

Although rare in developed countries, arrow-shot injuries remain a significant cause of penetrating trauma in rural regions of developing nations, particularly in areas affected by herder–farmer conflicts. Despite being low-velocity projectiles, arrows can cause severe penetrating injuries to the head and neck, thorax, abdomen and extremities, often requiring surgical intervention. Data from Gombe State are scarce, and these injuries appear to occur more frequently during harvest periods when herder-farmer clashes are more common.

We report three cases of arrow-shot injuries sustained during herder – farmer clashes in Gombe, Nigeria. The injuries involved the neck, thorax and retroperitoneum with damage to major structures including the internal jugular vein, lung, diaphragm and kidney. All patients underwent operative management following appropriate imaging and resuscitation.

All patients had favourable outcomes, with no major postoperative complications or mortality. This case series highlights the potential life-threatening nature of arrow shot injuries and emphasises the importance of early resuscitation, appropriate imaging, and controlled surgical extraction. Improved surveillance and targeted trauma preparedness during high-risk periods may further reduce morbidity and mortality associated with these injuries.

Keywords: Arrow-shot injuries, Herder-Farmers Conflict, Penetrating trauma.

Cite this article: Mshelia N, Aroungudade A, Ndenwaneku SO, Ogbeide J, Adamu S, Ajiboye IG. Arrow-shot injuries following herder–farmer clashes in Gombe, Nigeria: a case series. Yob Med J.2025;2(2):167-174

Introduction

Injuries from arrow shots are rare in developed countries due to the development of modern firearms and ballistics¹. However, it is still seen in rural areas in developing countries where conflicts between herders and farmers are common¹. Bow and arrow are common weapons of war among locals used during conflict between herders and farmers over grazing land, farm land disputes between farmers, armed banditry, cattle rustling, political violence and other forms of criminality²⁻⁴. Arrows are common because they are cheap and easy to fabricate. Even though arrows are classified as low-velocity projectiles, they can cause significant penetrating injuries^{1,4}. Injury severity depends on several factors such as distance fired, trajectory, anatomical region involved and arrowhead design (e.g. barbed versus Broad-headed tips). Some of these arrows are thought to be dipped in poisonous substances, such as snake venom and faecal matter, to increase their deadly potential⁵. Being low-velocity projectiles, they are usually lodged in the body and may initially tamponade injured vessels. Hence, unskilled prehospital removal can precipitate massive haemorrhage. Furthermore, they should not be removed blindly depending on the arrowhead design, as pushing it along its trajectory may be safer than extraction in the opposite direction⁶.

Any part of the body can be affected, and many case series in Nigeria have reported arrow injuries affecting the neck, orbit, face, abdomen and the thoracic region, often requiring complex surgical intervention^{4,7,8}.

Data from Gombe state remain sparse, and based on clinical observation, arrow shot injuries appear to demonstrate a seasonal pattern with more cases encountered during the harvest period when herder-farmer interactions intensify. However, the true burden is underestimated due to reliance on traditional care^{4,7}.

In the present series, all 3 cases were presented within four days during the most recent harvest season, suggesting increased occurrence during this time frame.

This series aims to describe the clinical presentation, pattern of injury, management strategies and outcome of patients presenting with arrow shot injuries during herder-farmer conflicts in Gombe and its environment. Highlighting the seasonal pattern of presentation underscores the need for improved surveillance and targeted surgical readiness during the high-risk period.

Case presentations

Case 1

A 26-year-old man was referred from a private hospital in Biu to the Accident and Emergency Unit of the Federal Teaching Hospital, Gombe, with a penetrating arrow injury to the neck of one day's duration. He sustained the injury after being shot with an arrow by Fulani herdsmen while attempting to prevent them from grazing on his farmland. There was a history of bleeding from the injury site, which was controlled with direct pressure. He also complained of mild pain on swallowing but denied difficulty in breathing, change in voice, loss of consciousness, or progressive neck swelling. No other injuries were sustained. The initial presentation was at a private facility in Biu, from where he was referred without intervention.

On examination, he was conscious, afebrile, and hemodynamically stable, with no respiratory distress. An arrow was noted to be impacted on the right side of the posterior triangle of the neck at the level of the mid-sternocleidomastoid muscle (Fig. 1). There was surrounding soft tissue swelling without an expanding hematoma, air bubbling, or crepitus, though the area was tender. Other systemic examinations were unremarkable. A plain radiograph of the neck demonstrated

a metallic arrow lodged in the right lateral soft tissues at the C2–C3 level, raising concern for possible vascular injury.

The patient received intravenous antibiotics and antitetanus prophylaxis and was prepared for surgery. He subsequently underwent neck exploration under general anaesthesia. Intraoperative findings revealed a barbed arrow traversing deep to the sternocleidomastoid muscle and lodging within, and tamponading the right internal jugular vein, with no active haemorrhage at the time of exploration. The incision was extended laterally from the entry wound, and following careful sharp and blunt dissection, the barbs and tip of the arrow were exposed. Proximal and distal vascular control was achieved, the arrow was gently removed, and the internal jugular vein was repaired primarily. Hemostasis was secured, the wound irrigated, and closed in layers over a drain.

Postoperatively, he was managed with intravenous ceftriaxone/sulbactam 1.5 g 12-hourly, paracetamol 600 mg 8-hourly, and nefopam 20 mg 8-hourly, and intravenous fluid with close monitoring. He made an uneventful recovery; the drain was removed 24 hours postoperatively, and he was discharged on the fourth postoperative day and scheduled for outpatient follow-up.



Figure 1 – Arrow impacted on the right posterior triangle of the neck.



Figure 2 – Anteroposterior neck radiograph showing the retained arrow.



Figure 3. Lateral neck radiograph showing the retained arrow.



Figure 4. Post Extraction and Wound Closure.

Case 2

AY, a 21-year-old male farmer, presented to the Accident and Emergency Unit of the Federal Teaching Hospital, Gombe, with multiple arrow-shot injuries to the anterior chest wall and left gluteal region, as well as lacerations to the scalp and left heel, sustained approximately two hours before

presentation. He was attacked while harvesting crops on his farm when Fulani herdsmen attempted to graze their cattle on his farmland. In trying to stop them, he was shot with arrows to the chest and left gluteal region and sustained machete cuts to the scalp and left heel. There was associated bleeding from the scalp, chest, and gluteal wounds, which was controlled with direct pressure. He complained of difficulty in breathing but denied dizziness or syncope. He was brought immediately to the emergency department following initial haemorrhage control.

On examination, he was conscious and in respiratory distress but not pale. Vital signs revealed tachycardia with a normal blood pressure. An impacted arrow was noted at the right parasternal region at the 5th intercostal space, directed inferomedially toward the right costal margin, as well as another arrow lodged in the left gluteal region. There was no active external bleeding. Multiple scalp lacerations and a deep laceration to the left heel with complete Achilles tendon transection were also noted. Chest examination revealed a centrally placed trachea, reduced chest expansion on the right hemithorax, dull percussion notes, and reduced air entry over the right lung fields.

An emergency right-sided chest tube was inserted on presentation, and the scalp lacerations were sutured in the emergency room. Chest and pelvic radiographs demonstrated retained arrow fragments in the right anterior chest wall and left lateral pelvis. Laboratory investigations, including complete blood count and serum electrolytes, were within normal limits. He subsequently underwent surgery comprising right thoracotomy with arrow extraction, repair of lung lingula and diaphragmatic lacerations, left gluteal wound exploration with arrow removal, and repair of the left Achilles tendon.

Intraoperatively, the thoracic arrow was found to have entered just to the right of the sternum at the fourth intercostal space, traversed anterior to the right ventricle, pierced the lower lobe of the right lung and the diaphragm, and abutted the diaphragmatic surface of the right lobe of the liver. The gluteal arrow was lodged within the left gluteus medius muscle. A right anterolateral thoracotomy was performed, the lung lingula and diaphragm were dissected to expose the barbed arrowhead, and the arrow was removed retrogradely. The lung and diaphragm were repaired, hemostasis secured, and the chest tube repositioned to optimize drainage. The gluteal arrow was removed following careful dissection of the gluteus medius, and the transected Achilles tendon was repaired using a modified Kessler technique with application of a backslab.

Postoperatively, the patient was managed in the intensive care unit with intravenous ceftriaxone/sulbactam 1.5 g 12-hourly, paracetamol 600 mg 8-hourly, and nefopam 20 mg 8-hourly. His recovery was uneventful, and he was transferred to the surgical ward after 24 hours. The chest tube was removed on postoperative day four, and he was discharged seven days later after completing antibiotics, with no postoperative complications.



Figure 5. Impacted Arrow in the Chest



Figure 6. Impacted Arrow in the Left Gluteal Region

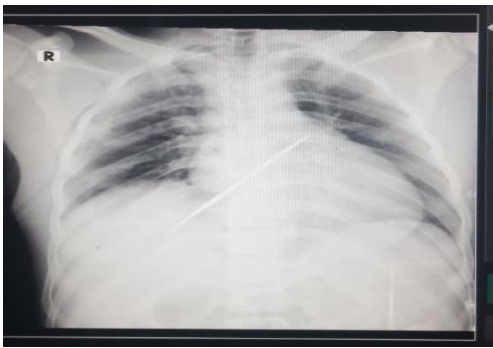


Figure 7. Chest X-ray – Anteroposterior View.



Figure 8. Pelvic X-ray – Anteroposterior View.

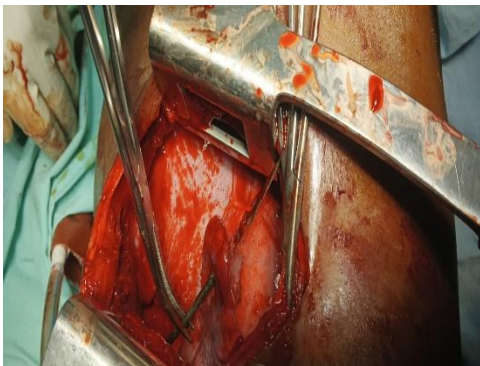


Figure 9. Intraoperative Thoracotomy – Demonstrating the Arrow in the Lungs

Case 3

A 23-year-old Fulani man was referred to our centre with a penetrating arrow injury to the left middle back of eight hours' duration following a dispute over farmland. He reported bleeding from the injury site and a single episode of hematuria. There was no history of dizziness, loss of consciousness, chest pain or difficulty in breathing. There was no other major injury sustained.

On clinical examination, he was conscious and not in respiratory distress with an arrow impacted in the left mid-back, and there was no active bleeding. He was hemodynamically stable. Plain abdominal X-ray showed an arrow in situ with possible left renal penetration. CT IVU showed the arrow traversing the upper pole of the left kidney, exiting medially with probable associated liver penetration.

The patient was prepared for surgery and underwent laparotomy via a midline incision under general anaesthesia with endotracheal intubation. A careful dissection was carried out until the arrow barbs were fully exposed at the renal hilum. The arrow barbs were gently clipped, and the arrow was gently removed retrogradely after cutting the extra abdominal wooden shaft. Primary repair of the renal injury was performed, reinforced with retroperitoneal fat.

Postoperatively, the patient had antibiotics and analgesics and had an uneventful recovery and was subsequently discharged with outpatient follow-up arranged.



Fig. 10 Impacted Arrow to the Back



Fig. 11 Sample of the extracted Arrow

Discussion

Arrow shot injuries are uncommon in the developed world. However, they are still seen in developing countries and are important causes of penetrating trauma, especially in rural parts of sub-Saharan Africa, including Northern Nigeria. This series highlights the clinical challenges, management and surgical outcome of three patients with penetrating arrow shot injuries involving different regions of the body.

All three patients in this series are male, consistent with previous reports from Northern Nigeria. A report of two cases of penetrating arrow injuries to the neck from Kano involved only male patients,¹ while another case series from the same region reported four male patients.⁴ Likewise, a retrospective analysis of thirty patients with orofacial arrow injuries at Federal Medical Centre Nguru, Northeast Nigeria, found that all affected patients were male³. The male predominance observed across these studies probably reflects the greater participation of man in farming activities and their frontline involvement during herder-farmer conflicts, predisposing them to such injuries.

Although arrows are classified as low-velocity weapons, they are capable of causing significant injuries if not managed properly and can be life-threatening. The degree and severity of the injuries depend on the distance from which the arrow is fired, the trajectory and the anatomical region involved. In this series, the injuries involved critical anatomical regions, including the neck (internal Jugular vein), thorax (Lung and diaphragm), pelvis, musculoskeletal

structures and the retroperitoneal region (Left kidney). These findings are consistent with other reports. Previous reports have described injuries involving the neck, nose and maxillofacial region, highlighting the diverse anatomical sites that may be affected.^{4,5} Although some injuries may appear localised, they can be life-threatening if not managed appropriately, particularly when major neurovascular structures are involved.^{4,5} A 10-year retrospective review of 73 patients at the University of Maiduguri Teaching Hospital showed that the thorax is the most commonly affected region, followed by the head and neck.⁹ In the present series, both regions were involved, with one patient sustaining injuries to multiple anatomical sites. The Predominance of thoracic and head-and-neck injuries may be due to the large exposed surface area of the thorax and the tendency of the assailants to aim vital structures of the neck for maximum damage. Recognition of these injury patterns is important for trauma planning, surgical preparedness, and training in the management of penetrating arrow injuries.

In this series, all three cases presented within a four-day window during the harvest season. Although this is only a clinical observation rather than an epidemiological finding, it aligns with the period of intensified herder-farmer interactions fueled by competition over farmland and harvested crops. This finding is consistent with a previous report at Aminu Kano Teaching Hospital, Kano, in which all cases of arrow-shot injuries occurred in the setting of herder-farmer conflict, although the timing of presentation was not specified.⁴ These observations suggest that periods of heightened herder-farmer tension may be associated with increased risk of arrow-shot injuries and underscore the need for enhanced surgical preparedness and trauma system readiness during such high-risk periods.

The pattern of presentation and management depends on the organ affected. All patients in this series were managed in line with ATLS protocol, following established principles for penetrating trauma. At the initial evaluation, life-threatening injuries that will necessitate immediate surgical exploration were looked for. All three patients were hemodynamically stable, and there was no need for immediate surgical intervention as part of the resuscitation. Notably, arrow injuries tend to remain lodged in the body, which may tamponade injured vessels and limit life-threatening haemorrhage. This was clearly demonstrated in case 1, in which the arrow was lodged and tamponading the internal jugular vein and in case 3, where renal injury was present yet the patient was hemodynamically stable. This temporary tamponade can be deceptive, and an ill-advised prehospital removal or manipulation can precipitate catastrophic bleeding. In all three cases, the arrow was not removed prehospital or in the emergency department. Instead, controlled surgical exploration under general anaesthesia allowed for direct visualisation, proximal and distal vascular control (where applicable), and careful extraction—often in an antegrade manner to avoid further tissue damage from barbed tips. This is in line with the fact that controlled surgical extraction under direct visualisation, with adequate proximal and distal vascular control where necessary, remains the cornerstone of management.

Imaging plays a vital role in the preoperative evaluation of these patients. Plain radiographs are useful in identifying the presence and general trajectory of retained arrows. A CT scan gives more details and is usually recommended for all patients who are hemodynamically stable. In our series, only one patient, Case 3, had a CT scan due to financial constraints. In the other patients, we depended on X-ray and clinical features to guide surgical exploration. Where

available, advanced imaging such as CT angiography is recommended, especially for penetrating neck and thoracic injuries; however, financial and infrastructural constraints frequently limit its use in low-resource environments.

The outcome for this series was favourable, with no mortality or major post-operative complications recorded. This highlights the importance of adequate resuscitation, adherence to trauma principles, timely surgical intervention, and multidisciplinary care, even in resource-constrained settings. It is important to note that multidisciplinary surgical readiness was essential, as evidenced by the need for vascular repair in Case 1, thoracotomy with visceral repair in Case 2, and laparotomy with renal repair in Case 3. This underscores the importance of prompt referral to a tertiary care centre with appropriate surgical expertise.

Conclusion

Arrow shot injuries remain a relevant cause of penetrating trauma in our environment, particularly in the context of herder–farmer conflicts. Clinical presentation varies depending on the anatomical region involved and whether prehospital attempts have been made to remove the arrow. Early resuscitation following Advanced Trauma Life Support (ATLS) principles, appropriate imaging, and controlled surgical extraction by a multidisciplinary team are essential for optimising outcomes. Strengthening referral pathways to tertiary centres and improving trauma preparedness during high-risk periods may further reduce morbidity and mortality associated with these injuries.

References

1. Adamu A, Ngamdu YB. Management of penetrating arrow neck injury: A report of two cases. *MAMC J Med Sci*. 2020;6:63–67. 64cb333b-e461-4cec-aafb-ed4ff8f...
2. Ismail A, Ismail N, Ali A, et al. Penetrating injury with an arrow

- impacted in the neck in rural Tanzania: A case report. *Int J Surg Case Rep.* 2022;94:107133.
3. Owobu T, Omeje UK, Agbebi SE, et al. Management of orofacial arrow injuries at Nigerian tertiary health care hospital: a report of 30 cases. *Ibom Med J.* 2022;15(1):76-82.
 4. Abdullahi H, Adamu A, Hasheem MG. Penetrating arrow injuries of the head-and-neck region: Case series and review of literature. *Niger Med J.* 2020;61(5):276–280.
 5. Biruar SOA. Navigating complex maxillofacial trauma: Arrow shot injury to the face by a speargun. *J Acute Med.* 2025;15(4):170–175.
 6. Shereen R, Oskouian RJ, Loukas M, Tubbs RS. Historical and modern principles in arrow injury management. *Cureus.* 2018;10(4):e2473.
 7. Adamu A, Garandawa HI, Nuhu AM, et al. A review of arrow shot injuries to the head and neck in Northeastern Nigeria. *Borno Med J.* 2021;18(2):1–7. 79856315-2c57-4268-ad5d-a039c46...
 8. Owobu T, et al. Orofacial arrow injuries in North-Eastern Nigeria: injury patterns and outcomes. *Ibom Med J.* 2022;15(1):76–82.
 9. Madziga AG. Arrow injuries in North East Nigeria. *West African Journal of Medicine.* 2003 Jun;22(2):106-109. DOI: 10.4314/wajm.v22i2.27926. PMID: 14529215.